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# EDITORIAL

The Journal of the BNHS begins its 86th year with a new look. A board of editors, consisting of leading experts in their respective fields of interest, has been constituted. This, we hope, will streamline the process of acceptance (and modification where needed) of papers.

The method of production of the Journal, too, has been changed. We have moved from the traditional letterpress printing to the offset process, which is quicker and gives better results. Page composing will now be done in-house, using computer software that can be upgraded, costs permitting, as and when improved programme versions become available.

With these changes, we have been able to reduce the number of pages (paper costs are rising sharply) without reducing the amount of text. This issue contains roughly the same material as do earlier issues.

The need for conservation of wildlife and habitats has never been more urgent. Our members have been generous with their support; and with their continued help, we are sure the Society will continue to fight, on the basis of well-researched information, for conservation in India.

J.C. Daniel
*Executive Editor*

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# THE BOSTAMI TURTLE, *TRIONYX NIGRICANS* ANDERSON: POPULATION STATUS, DISTRIBUTION, HISTORICAL BACKGROUND AND LENGTH-WEIGHT RELATIONSHIP[1]

MD. FARID AHSAN[2] AND MD. ABU SAEED[3]

A study was conducted on the population status, distribution, historical background and length-weight relationship of Bostami turtle, *Trionyx nigricans* Anderson, between September 1984 and August 1986. Total population has been estimated as 320 individuals. A significant length-weight relationship was obtained (P 0.001), where the values of 'r' were 0.959 for CL/CW, 0.921 for CL/TW and 0.965 for CW/TW.

## INTRODUCTION

The freshwater turtle, *Trionyx nigricans* is endemic to Bangladesh (Khan 1982a). Anderson (1875) first identified *T. nigricans* from a couple of specimens at the Indian museum which were collected from a "Tank of Chittagong." Annandale (1914) gave a common name "Chittagong mud turtle" to this taxon. However, Khan (1980) suggested a new name, Bostami turtle, as "this turtle does not have a common English name and is not found anywhere other than in the Bayazid Bostami Pond." In the present work Khan's name has been followed, though sometimes it is locally called 'Gazari' or 'Madari.'

In Bangladesh, scientific study of this turtle has so far been very limited. Ahamed (1955), Shafi and Quddus (1977), and Husain (1979) reported some preliminary information regarding turtles and tortoises of Bangladesh, but none of them mentioned the Bostami turtle. Since Annandale (1914), Khan's works (1980, 1982a, b and 1987) have been the only studies on the Bostami turtle. Recently, Haque (1985), and Ahsan and Haque (1986) studied the breeding ecology and ethology of the Bostami turtle. Apparently the species has never existed in the wild state, but a semi-captive colony has become established in an enclosed pond of the shrine of Hazrat Sultan Bayazid Bistami[4] of Chittagong. The shrine is about 6.5 km north-

---

[1] Accepted October 1987.

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[4] Locally pronounced Bostami.

west of Chittagong City.

The objectives of the present study were:

I. to assess the distribution and present status; II. to determine the age-composition and sex-ratio; III. to trace out the historical background, and IV. to find out the length-weight relationship of Bostami turtle.

## STUDY AREA

The shrine of the famous saint Hazrat Sultan Bayazid Bistami is situated on a hillock at Nasirabad, an industrial area of Chittagong City. Formerly, it was an idyllic spot of scenic beauty about 6.5 km to the north-west of Chittagong City. It lies at c. 22° 11' N and 99° 09' E. The Bostami pond is situated at the foot of a hill about 50 metres in height, the top of which has the 'astana' and 'chilla' of the shrine of Hazrat Sultan Bayazid Bistami. The pond has been excavated and expanded many times. Currently it is about 94.64 m by 61.27 m and rectangular in shape.

The water depth of the pond fluctuates in different seasons. During the monsoon, it may rise upto about 5 m or so which goes down to about 2.5 m before the onset of the next monsoon. The source of water in the pond is mainly rainfall. The water in the pond is more or less clear except during the monsoon.

The concrete area wall surrounding the pond supports mainly algae, mosses and some plants like ferns, grasses, etc. The following trees are mainly found on the bank: Kanthal (*Artocarpus heterophyllus*), Dab (*Cocos nucifera*), Aam (*Mangifera indica*) and Jam (*Syzygium cumini*).

The study period extended between September 1984 and August 1986.

## METHODS

**Census technique:** The population status was determined by directly counting the turtles following capture, mark and release method (modified from Joly 1965 and Plummer 1977). Both the 'Dargah' pond and adjacent ditches were included in the study. The turtles have been categorised into adult males, adult females, and young. Young were identified by their comparatively smaller size. Generally, adult males are larger than the adult females. The male and female were distinguished except in a few cases by the following characters.

1) The tail of the female is shorter than that of male, and does not protrude outside the carapace.
2) The carapace of the female is less oval than that of the male.
3) The body of the female is thicker than that of the male.
4) The distance between the two hind legs of the female is greater than that in the male.
5) Adult males are much larger than females.

For counting, individual turtles were marked with a water- proof "Epoxy paint" after cleaning and drying an area of the carapace.

**Historical background:** The history of the turtles was traced by searching through literature, interviewing the local people and through discussions with the historians of the University of Chittagong.

**Length-weight relationship:** A total of 100 (54 males and 46 females) specimens were randomly selected and measured for this purpose. Measurements of length, width and weight were taken to the nearest cm and kg respectively.

The following measurements were taken for each specimen.

a) *Carapace-length*: Carapace length was measured from the point of dorsal anterior-most edge of the carapace to the point of dorsal posterior-most edge of the same. The measurement invariably corresponded to the vertical line.

b) *Carapace-width*: Carapace-width was measured from the points between both the dorsal side edges of the carapace where the width was highest. The measurement point invariably corresponded to about anterior one- third of the carapace length.

c) *Total wet-weight*: Each live specimen was lifted out of water and placed inside a gunny bag and then weighed with the help of a spring balance. The actual weight of each specimen was determined by deducting the weight of the gunny bag from the total wet-weight.

## RESULTS AND DISCUSSION

**Population status:** In all, 284 turtles were counted in the Bostami pond and 16 in a separate ditch. The counting was spread over a period of five continuous days. As the turtles spend some time lying buried under mud, it might be possible that a few individuals were missed. However, it is suggested that not more than 320 were available at that time. Of the counted turtles, 162 (54%), 108 (36%) and 30 (10%) were male, female and young respectively. The ratio of adult male-female was 1.5:1.

Khan estimated 150 to 200 turtles in 1980 and 200 in 1982a in the Bostami pond of which 30-40 were young, 60-90 juveniles, and 60-70 adult or old animals. However, his estimates were merely assumptions. The East Pakistan, District Gazetteers, Chittagong, Rizv 1970, reported several hundred turtles in the Bostami pond while Ali (1964) reported the pond as a big tank containing a huge number of turtles. Plummer (1977) recorded the sex-ratio of *T. muticus* as 6.8:1 adult male and female and 1.98:1 all male and female (60 mm or larger in size) which varied seasonally. In the present study the adult male-female sex-ratio of *T. nigricans* was 1.5:1. This variation might be due to habitat and geographical distribution of the species. *T. muticus* was studied in a river while *T. nigricans* is from a pond.

**Distribution:** *T. nigricans* is an endemic species of Bangladesh (Khan 1982a). Khan (1980, 1982 a & b) and Annandale (1914) reported that *T. nigricans* was found only in a pond attached to the shrine of Bayazid Bostami. We found that besides the Bostami pond the turtles are also present in the adjacent ditches which they have possibly invaded from the Bostami pond. The turtles in the ditches were mostly females. The females wandered out for egg-laying and could not return to the pond due to many reasons. Probably the female turtles got into the nearest water body after egg-laying, and then lost their way and ultimately become separated from the original stock by some barriers like boundary walls, buildings etc.

**Historical background:** The Bostami turtle is not only an endemic species in Bangladesh, it is restricted, as far as is known, to the Bostami area of Chittagong City. There exists a strong religious belief about these turtles and their attachment to the shrine of Saint Bayazid Bistami. These two things interested us enough to trace out its historical background. The Bostami turtle has been named so,after the saint Sultan al-Arefin Hazrat Bayazid Bistami.

Almost no information on the historical background of *T. nigricans* is on record. There is a tale that these turtles were brought into the Bostami pond by the Saint himself. Locally, it is also believed that these turtles were once sinful men associated with the Saint who changed them into turtles as a punishment for their wickedness. There is another belief that these turtles were scared and 'djinns' (evil spirits) brought by the Saint himself. They were turned into the present shape because they incurred the wrath of the Saint.

However, the general belief is that the famous Iranian Sufi, Sultan al-Arefin Hazrat Bayazid Bistami is buried in this shrine, and so, the whole area has been named Bayazid Bostami and the road in front is called Bayazid Bostami Road after him. The influence of the shrine 'dargah' or 'mazar' in the minds of the local people may be gauged from this. Sultan Bayazid Bistami is a historical figure. He was born in 777 A.D. at Bistam in Iran and died in 874 A.D. (Ali 1964). His mazar is actually situated in Bistam (Arberry 1963). So, there is no 'mazar' of the Saint in the shrine. It is an 'astana' and 'chilla' associated with the name of the great Saint. In the 15th century there was a king in Bengal named Shihab al-din Bayazid Shah. Possibly it is his grave and his name might have been modified as Sultan Bayazid Bistami by some followers. However, it is known that Bayazid Bistami once came to sind to meet his teacher Abu Ali Sindhi and then he might have visited Chittagong (Huda 1985). If so, he might have carried the turtles with him here. So, the species might be present in Iran, Sind or other places from where he collected it. But there is no record of these turtles except from Chittagong (Bayazid Bostami area). This turtle (*T. nigricans*) may be a synonym of an other species of the genus *Trionyx* or may be a sub-species or variety of a species of *Trionyx*.

There is an assumption (Khan 1987) that the

Bostami turtle has evolved from *Trionyx gangeticus* as a result of long isolation.

**Length-weight relationship:** In general, knowledge about the length-weight relationship is very useful in fisheries management and population analysis.

A size frequency distribution data of 100 specimens are given in Table 1. The minimum and maximum values respectively. were 39 cm and 78 cm. in case of carapace-length (CL), 33 cm and 71 cm in case of carapace-width (CW) and 07 kg and 54 kg in case of total body wet-weight (TW) (Appendix). The mean of CL was 62 ± 10.16 cm, of CW was 53.27 ± 9.27 cm and of TW was 28.92 ± 12.71 kg.

Mathematical relationships between carapace-length, carapace-width and total wet body-weight were determined from the data given in Table 1. The regression values were calculated (Table 2).

From the correlation co-efficient values (Table 2) and scattered diagrams (Figs. 1 to 3) a highly significant linear relationship became evident between CL and CW, CL and TW, and CW and TW.

Size frequency distribution (Table 1) showed that the males are generally larger than the females. The male population showed that 64-78 cm length group size was dominant and in case of the female 39-53 cm length group size was dominant.

During the present study it has been found that turtles of the same length widely differed in total body wet-weight. For instance, five specimens with a carapace length of 73 cm had 17, 45, 38, 37 and 42 kg body wet-weight (Appendix).

ACKNOWLEDGEMENTS

We are thankful to Mr. Muhammad Shah

TABLE 1

RELATIONSHIP OF CARAPACE-LENGTH AND TOTAL BODY–WET-WEIGHT (FOR OBSERVED AND CALCULATED WEIGHT) IN 8 SIZE GROUPS IN *T. nigricans* (NO. OF MALE = 44, NO. OF FEMALE = 56)

| Size group in cm | Sex M-Male F-Female C-combined | Mean carapace length (CL) in cm | Mean Total body wet-weight (TW) in kg | |
|---|---|---|---|---|
| | | | *(TW) | **(TW) |
| 39-43 | M | | | |
| | F-5 | 41.6 | 8.4 | 8.4 |
| | C | | | |
| 44-48 | M | | | |
| | F-7 | 46.43 | 11.57 | 11.56 |
| | C | | | |
| 49-53 | M | | | |
| | F-14 | 49.86 | 14.28 | 14.26 |
| | C | | | |
| 54-58 | M-3 | 57.67 | 19.67 | 19.67 |
| | F-6 | 54.83 | 18 | 17.99 |
| | C-9 | 55.78 | 18.55 | 18.54 |
| 59-63 | M-6 | 62.25 | 30.25 | 30.24 |
| | F-2 | 60 | 23.5 | 23.5 |
| | C-8 | 61.5 | 28 | 28 |
| 64-68 | M-18 | 66.28 | 34 | 34 |
| | F-6 | 66 | 33.33 | 33.31 |
| | C-24 | 66.21 | 33.5 | 33.4 |
| 69-73 | M-26 | 70.88 | 39.27 | 39.27 |
| | F-3 | 70.33 | 39 | 39 |
| | C-29 | 70.83 | 39.24 | 39.23 |
| 74-78 | M-5 | 76.2 | 48.4 | 48.3 |
| | F-1 | 74 | 50 | 49.99 |
| | C-6 | 75.83 | 48.67 | 48.67 |

*TW — observed value, **TW — Calculated value.

TABLE 2

CALCULATED VALUES OF STANDARD DEVIATION, REGRESSION CO-EFFICIENTS, INTERCEPT AND CORRELATION CO-EFFICIENT IN THE CL/CW, CL/TW AND CW/TW RELATIONSHIP IN BOSTAMI TURTLE *T. nigricans*

| Relationship between | | Values of sd (x) | Values of sd (y) | Values of regression co-efficient (b) | Values of intercept (a) | Values of correlation co-efficient (r) |
|---|---|---|---|---|---|---|
| Ordi. (x) | Abscl. (y) | | | | | |
| CL | CW | ± 9.27 | ± 10.16 | 0.87472 | — 1.00264 | 0.959 (P< 0.001) |
| CL | TW | ± 12.71 | ± 10.16 | 1.15279 | — 42.55298 | 0.921 (P< 0.001) |
| CW | TW | ± 12.71 | ± 9.27 | 1.323310 | — 41.508613 | 0.965 (P< 0.001) |

Alam, Chairman, Department of Zoology, University of Chittagong for all possible departmental facilities.

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## APPENDIX

CARAPACE-LENGTH, CARAPACE-WIDTH AND TOTAL WET-BODY WEIGHT OF 100 SPECIMENS OF *T. nigricans*

| Sl. No. | Carapace length (CL) in cm | Carapace width (CW) in cm | Total wet-body Weight (TW) in kg. | Sex |
|---|---|---|---|---|
| 1. | 65 | 58 | 47 | M |
| 2. | 75 | 63 | 47 | M |
| 3. | 54 | 48 | 18 | F |
| 4. | 64 | 53 | 27 | M |
| 5. | 49 | 42 | 12 | F |
| 6. | 73 | 64 | 17 | M |
| 7. | 67 | 56 | 31 | M |
| 8. | 49 | 42 | 14 | F |
| 9. | 73 | 63 | 36 | M |
| 10. | 49 | 45 | 16 | F |
| 11. | 72 | 64 | 54 | M |
| 12. | 50 | 42 | 14 | F |
| 13. | 68 | 57 | 35 | M |
| 14. | 44 | 34 | 09 | F |
| 15. | 73 | 71 | 45 | F |
| 16. | 69 | 57 | 31 | M |
| 17. | 68 | 64 | 40 | F |
| 18. | 70 | 60 | 38 | M |
| 19. | 68 | 61 | 36 | F |
| 20. | 67 | 58 | 35 | F |
| 21. | 71 | 64 | 41 | M |
| 22. | 68 | 57 | 35 | M |
| 23. | 74 | 68 | 50 | F |
| 24. | 71 | 61 | 43 | M |
| 25. | 55 | 43 | 15 | F |
| 26. | 64 | 60 | 34 | F |
| 27. | 48 | 42 | 13 | F |
| 28. | 63 | 58 | 33 | M |
| 29. | 70 | 60 | 34 | M |
| 30. | 66 | 53 | 31 | M |
| 31. | 77 | 63 | 49 | M |
| 32. | 63 | 51 | 29 | M |
| 33. | 71 | 64 | 46 | F |
| 34. | 46 | 40 | 12 | F |
| 35. | 75 | 65 | 51 | M |
| 36. | 65 | 53 | 22 | M |
| 37. | 65 | 56 | 36 | M |
| 38. | 70 | 61 | 47 | M |
| 39. | 55 | 49 | 21 | F |
| 40. | 68 | 64 | 43 | M |
| 41. | 50 | 42 | 15 | F |
| 42. | 64 | 56 | 31 | M |
| 43. | 64 | 53 | 27 | F |
| 44. | 65 | 50 | 32 | F |
| 45. | 54 | 45 | 18 | F |
| 46. | 43 | 35 | 08 | F |
| 47. | 66 | 58 | 34 | M |
| 48. | 70 | 61 | 36 | M |
| 49. | 48 | 40 | 11 | F |
| 50. | 69 | 63 | 43 | M |
| 51. | 67 | 58 | 31 | M |
| 52. | 70 | 61 | 43 | M |
| 53. | 57 | 47 | 19 | M |
| 54. | 73 | 61 | 38 | M |
| 55. | 49 | 41 | 13 | F |
| 56. | 57 | 49 | 20 | F |
| 57. | 71 | 60 | 40 | F |
| 58. | 67 | 60 | 34 | M |
| 59. | 70 | 62 | 37 | M |
| 60. | 41 | 37 | 09 | F |
| 61. | 45 | 39 | 12 | F |
| 62. | 73 | 62 | 37 | M |
| 63. | 70 | 58 | 42 | M |
| 64. | 73 | 65 | 42 | M |
| 65. | 50 | 42 | 13 | F |
| 66. | 65 | 54 | 31 | M |
| 67. | 69 | 59 | 36 | M |
| 68. | 66 | 56 | 33 | M |
| 69. | 67 | 56 | 34 | M |
| 70. | 61 | 50 | 25 | M |
| 71. | 47 | 41 | 15 | F |
| 72. | 58 | 47 | 22 | M |
| 73. | 43 | 39 | 09 | F |
| 74. | 71 | 60 | 38 | M |
| 75. | 78 | 62 | 49 | M |
| 76. | 70 | 62 | 42 | M |
| 77. | 68 | 57 | 33 | M |
| 78. | 76 | 66 | 46 | M |
| 79. | 47 | 42 | 09 | F |
| 80. | 50 | 45 | 16 | F |
| 81. | 71 | 61 | 40 | M |
| 82. | 49 | 39 | 14 | F |
| 83. | 49 | 41 | 13 | F |
| 84. | 52 | 47 | 15 | F |
| 85. | 70 | 60 | 39 | M |
| 86. | 71 | 60 | 40 | M |
| 87. | 49 | 42 | 16 | F |
| 88. | 69 | 61 | 37 | M |
| 89. | 72 | 61 | 41 | M |
| 90. | 54 | 47 | 16 | F |
| 91. | 67 | 56 | 32 | M |
| 92. | 69 | 59 | 35 | M |
| 93. | 53 | 44 | 16 | F |
| 94. | 50 | 42 | 13 | F |
| 95. | 62 | 56 | 34 | M |
| 96. | 42 | 35 | 09 | F |
| 97. | 58 | 49 | 18 | M |
| 98. | 60 | 50 | 23 | F |
| 99. | 60 | 49 | 24 | F |
| 100. | 39 | 33 | 07 | F |

# NOTES ON THE STATUS AND DISTRIBUTION OF SOME BIRDS IN SRI LANKA AS LISTED IN S. D. RIPLEY (1982) "A SYNOPSIS OF THE BIRDS OF INDIA AND PAKISTAN, TOGETHER WITH THOSE OF NEPAL, BHUTAN, BANGLADESH AND SRI LANKA.

THILO W. HOFFMANN[2]

These notes refer to omissions, inaccuracies and changes relating to the status and distribution of some birds in Sri Lanka as given not only in Ripley's SYNOPSIS, but also in the 10 volume HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN by Salim Ali and S. Dillon Ripley (1968-74; also 2nd Edition Vols. 1 - 5). The list of amendments is quite appreciable. In 1981, when I first had occasion to look through Vol. 2 of the 2nd Edition of the HANDBOOK, I wrote to Dr Salim Ali and the contents of that letter were subsequently published in the *JBNHS* (Hoffmann 1983). That note only dealt with some waders, whereas the present paper has taken account of the full range of species of birds which are found in Sri Lanka. Characteristically, waterbirds, especially waders, provide by far the greatest number of new records and new information about distribution and status.

I have edited the Ceylon Bird Club Notes (CBCN) since 1971, and it is chiefly on the basis of these monthly Notes that the present paper was written, though much of the information is founded on my own observations. The monthly Ceylon Bird Club Notes (50-70 foolscap pages of stenciled material per annum since 1944) are mailed to the Bombay Natural History Society, and Dr. Dillon Ripley is a subscriber. It is suggested that more attention be paid to these Notes which come with an annual Species Index.

In the following text, the numbers given against each species are identical with those in the Synopsis and the Handbook. The relevant statement in the Synopsis is quoted within inverted commas.

7. **Whitefronted Shearwater** (*Procellaria leucomelaena*).
"Accidental. A single specimen was obtained off Sri Lanka in 1884".
A sight record off Talaimannar in September 1978 (van den Berg 1982).

13a. **Jouanin's Gadfly Petrel** (*Bulweria fallax*).
"May occur in Indian waters"
Sri Lanka not mentioned. One was collected at Colombo in January 1978 (Kotagama 1980). New record.

14. **Wilson's Storm Petrel** (*Oceanites oceanicus oceanicus*).
"....Sri Lanka, where it is apparently common in summer (May-November, Gulf of Mannar)".
Considerable numbers of this petrel accompany the annual north-south post-breeding mass dispersal of Brown-winged Terns (*Sterna anaethetus*) along the west coast of Sri Lanka, first discovered and described by me in September 1972 (CBCN 1972: 42, 1982: 55-57, see also van den Berg 1982).

25. **Brown Booby** (*Sula leucogaster plotus*).
"... recorded off the Malabar and Sri Lanka coasts in the north-east monsoon".
A straggler to the Sri Lanka coasts; seen in Colombo in February-April, also east coast and as part of the annual post-breeding dispersal of Brown-winged Terns in August-September.

50. **Indian Reef Heron** (*Egretta gularis schistacea*).
"The seaboard of ...northwestern Sri Lanka".
The Reef Heron has in recent years been seen on all coasts of Sri Lanka, in Colombo, Bentota, the Hambantota area in the south and the east coast.

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[1] Accepted June 1987.

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59. **Bittern** (*Botaurus stellaris*).
Sri Lanka not mentioned. A specimen now in the Colombo Museum, was obtained at Panadura on the west coast on 14.10.1985 (CBCN 1985: 49). A probable sight record in March 1987 at Deniyaya. New record.

63. **White Stork** (*Ciconia ciconia*).
Sri Lanka not mentioned. Rare winter vagrant to Sri Lanka. Noted already in last century (Legge) but several reliable sight records in last 25 years in different parts of the low country, mostly in the south (CBCN).

66. **Blacknecked Stork** (*Ephippiorhynchus asiaticus*).
"Resident ... Sri Lanka".
This bird has become very rare in Sri Lanka, only a few breeding pairs being known from the Yala National Park complex; the nest has never been found. An endangered species in Sri Lanka.

68. **Lesser Adjutant** (*Leptoptilos javanicus*).
"Resident ... Sri Lanka".
Declining to the extent of becoming endangered due to loss of undisturbed breeding sites.

71. **Glossy Ibis** (*Plegadis falcinellus falcinellus*).
"A migrant to Sri Lanka".
A breeding resident in the last century, both in the North and South. Then it disappeared and was not seen for many years. In the last 3 decades the species has been observed in increasing numbers throughout the year and may actually again be breeding in the Kalametiya Sanctuary (south coast near Tangalle).

73. **Flamingo** (*Phoenicopterus roseus*)
"Resident ... Sri Lanka".
Formerly mainly a winter visitor in varying but sometimes large numbers from the Rann of Kachchh. Of late recorded throughout the year but not known to breed in Sri Lanka. Suitable feeding sites more and more subject to disturbance and conversion into salterns or aquaculture projects (e.g. Karagan Lewaya at Hambantota, salterns at Elephant Pass).

103. **Wigeon** (*Anas penelope*).
"Sparse and irregular in Sri Lanka".
Till 1980 only 4 records, then in November several hundred were seen in the Jaffna Peninsula (CBCN 1980: 56). Over 10,000 were recorded in the Jaffna Peninsula during the 1983 midwinter waterfowl count. In 1984 there were over 12,000 in Jaffna and 6,000 in the Mannar area. It would appear that large numbers of this duck now regularly visit the North of Sri Lanka during the winter; very few, however, penetrate to the south of the country, in contrast to Pintail and Garganey.

111. **Tufted Duck** (*Aythya fuligula*).
"Migrant to Sri Lanka (one record)"
There are two records, the second from Giant's Tank near Mannar in 1962 (Phillips 1978).

126. **Blyth's Baza** (*Aviceda jerdoni*); in Sri Lanka called Legge's or Ceylon Brown Baza.
"In evergreen biotope up to *c*.900 m".
Most recent sightings of this raptor were in well shaded tea areas, where the bird also breeds, and montane forest at altitudes between 1800 and 1900 m (Nuwara Eliya).

133. **Pariah Kite** (*Milvus migrans govinda*).
"Resident throughout the subcontinent and Sri Lanka".
In Sri Lanka this species is confined to the coastal areas of the north of the island (Mannar, Jaffna) and very rarely is a straggler reported from other coastal points. Most birds seem to be winter migrants from South India.

151. **Besra Sparrow-Hawk** (*Accipiter virgatus besra*).
"In heavy evergreen and moist-deciduous forest".
In Sri Lanka this species is also found in the Dry Zone monsoon forest (dry deciduous forest).

153. **Longlegged Buzzard** (*Buteo rufinus*).
Sri Lanka not mentioned. A first-year bird of this species was closely observed in January 1988 at Horton Plains (2100 m) by Ben King with James and Robert Clements. A new record.

161. **Crested Hawk-Eagle** (*Spizaetus cirrhatus andamanensis*).
"In deciduous and semi-evergreen forest".
This species is found in Sri Lanka in all climatic zones which include heavy evergreen forests in the Wet and Hill Zones.

187. **Egyptian Vulture** (*Neophron percnopterus ginginianus*).
"Straggler to Sri Lanka".
A single reliable record in 1874 (Phillips 1978). Not seen since.

211. **Shahin Falcon** (*Falco peregrinus peregrinator*).
"Resident ... Sri Lanka. Affects rugged hills".
This handsome and quite rare race of the Peregrine Falcon has of late also taken to towns; for instance individuals can be observed in Colombo for months on end. Whether it also breeds in towns is not known.

242. **Painted Partridge** (*Francolinus pictus watsoni*).
"Resident. Sri Lanka in the dry zone of Uva Province, up to *c.* 1200 m".
This endemic subspecies has become very rare, as natural habitats in its former stronghold, the rolling grass hills (patnas) of the Uva Plateau (average elevation 1000 m), have all but disappeared since the war, due to heavy settlement and intensive vegetable cultivation on even the steepest slopes. Still found in the small Gal Oya National Park and west of it in the eastern foothills. An endangered species.

246. **Grey Partridge** (*Francolinus pondicerianus pondicerianus*).
"Sri Lanka in the Jaffna Peninsula and northwestern coastal islands".
This partridge has extended its range southward along the west coast as far as about Chilaw, and in the east is found as far as Mullaitivu. Like many birds (e.g. ducks and waders) and other wildlife, this species profits from the ethnic trouble which currently plagues Sri Lanka and virtually precludes hunting.

279. **Ceylon Spurfowl** (*Galloperdix bicalcarata*).
"Resident. Sri Lanka, in the Eastern and Uva Provinces".
This endemic species is found throughout the Wet Zone in the west and south of the island wherever there is any tall forest left (e.g. Labugama near Colombo, Sinharaja, etc.), right up to the highest hills (e.g. Horton Plains, 2100 m); it is also found in undisturbed forest in the eastern foothills.

350. **Coot** (*Fulica atra atra*).
"Resident and winter visitor, throughout the subcontinent and Sri Lanka".
In Sri Lanka this waterbird was first noted in 1924 and has since then been confined to the Giant's Tank area near Mannar. In recent years it has, however, spread to tanks (reservoirs) in the Anuradhapura area, and recently one was seen in the extreme south. Breeding not known to occur but several pairs with young have been observed on a tank near Thiruketheeswaram

Temple (Mannar District) in May and July 1984, as well as in June 1985. Thus this species is now a scarce breeding resident in Sri Lanka.

370. **Yellow-wattled Lapwing** (*Vanellus malabaricus*).
"Sri Lanka in the low-country dry zone"
This species is not generally found in the dry zone, but very localized in defined coastal areas (e.g. Yala National Park, Pomparippu plain in Wilpattu National Park, open plains in the Mannar area).

376. **Caspian Plover** (*Charadrius asiaticus asiaticus*).
"Migrant. Recorded from the coast of Bombay, Sri Lanka and Maldive Is.".
Until recently there were only two records of this bird in Sri Lanka (Phillips 1978), but in 1985 several were seen in Yala National Park and the Bundala Sanctuary. 6 birds were observed in the Bundala Sanctuary in 1986/87. In winter plumage this species is difficult to identify and is easily mistaken for the Lesser Sand Plover (*Charadrius mongolus atrifrons*), a common winter visitor, and may thus be overlooked.

378. **Ringed Plover** (*Charadrius hiaticula tundrae*).
"Winter visitor or straggler. Only a half-dozen records".
Sri Lanka not mentioned. Like other rare waders, this bird has been recorded more frequently in the recent past. Phillips (1978) mentions several sight records, the first in 1944, the second in 1973. At least 4 were reliably reported between January and April 1987, 4 in 1986, 7 in 1985 and 4 in 1983. Obviously individuals of this species are also overlooked.

389. **Blacktailed Godwit** (*Limosa limosa limosa*).
"Winter visitor to Pakistan and north-western India... decreasing southwards to the southern peninsula and Sri Lanka".
Considered a migrant to Sri Lanka till after the war. Numbers of regular wintering birds have increased so much in recent years that it must now be regarded as a common and plentiful winter visitor to the coastal regions of the Dry Zone both in the North and South; roosts of up to 5000 have been observed. Today this bird can be seen in winter at every suitable coastal location; non-breeding birds loiter throughout the summer.

403. **Asian Dowitcher** (*Limnodromus semipalmatus*).
Sri Lanka not mentioned. In July 1982 one was seen at Hambantota (CBCN 1982: 28b). A new record.

411. **Woodcock** (*Scolopax rusticola rusticola*).
"Scarce in Sri Lanka above *c*. 1500 m".
Recently (December 1986) one was obtained in a coastal garden at Colombo (CBCN 1986: 56) and another was seen in March 1987 in a marsh near Colombo (CBCN 1987: 27).

412. **Knot** (*Calidris canutus canutus*).
"Straggler : Sri Lanka".
Not as rare as previously thought. In recent years a few are recorded annually, especially from the area around Mannar but also the south (CBCN).

413. **Eastern (or Great) Knot** (*Calidris tenuirostris*).
"Isolated records from Assam, Calcutta and Madras".
Sri Lanka not mentioned. First sight record of 4 birds by Ben King in March 1981 at Mannar (CBCN 1981: 24). Several in 1983, also at Mannar (CBCN 1983: 38). A new record.

423. **Spoonbilled Sandpiper** (*Eurynorhynchus pygmeus*).
"Straggler or very rare winter visitor to the coast of Bangladesh and West Bengal".
Sri Lanka not mentioned. In March 1978 Ben King recorded a specimen of this species in Bundala Sanctuary (CBCN 1978: 7, 20), and another one was seen in November at Bentota (CBCN 1978: 66) in a small flock of Sanderling, also in December 1979 at Bundala (CBCN 1979: 46). New record.

425a. **Buffbreasted Sandpiper** (*Tryngites subruficollis*).
"Accidental. One specimen record, 5 August 1960 and a sight record, November 1974 from Sri Lanka".
The specimen is from Kalametiya in the South, and the sight record was from Trincomalee. A further reliable sight record in January 1985 from the Bundala Sanctuary (CBCN 1985:2).

427. **Rednecked Phalarope** (*Phalaropus lobatus*).
"One record from Sri Lanka. Pelagic, …., on passage, ponds and shallow jheels".
In recent years this species has been regularly noted during winter, especially in the Bundala Sanctuary. The birds (sometimes as many as 5 or 6 together in small flocks) stay in the same area throughout.

432. **Avocet** (*Recurvirostra avosetta*).
"Straggler to Sri Lanka".
Has become a regular winter visitor in small numbers not only in the North around Mannar, but also in the South (e.g. Bundala Sanctuary).

434. **Crab Plover** (*Dromas ardeola*)
"Winter visitor to the coasts of Sri Lanka".
Phillips, in his 1978 Checklist, records it as a scarce breeding resident and states: "Undoubtedly breeds in Ceylon about end of May or earlier, but the eggs have not yet been found". The writer saw a flock of 35 including 6 sub-adults in March 1978 at Devil's Point between Mannar and Jaffna. Mostly observed in the north of Sri Lanka, i.e. Adam's Bridge area, Mannar and north-west coast, but occasionally also in the south.

440. **Indian Courser** (*Cursorius coromandelicus*).
"Sri Lanka in the low-country dry zone"
Mostly confined to the arid area around Mannar and coastal islands to the north (e.g. Delft) where its biotope is found.

447. **Pomatorhine Skua** (*Stercorarius pomarinus*).
"Straggler to Sri Lanka (one record)".
There have been a number of sight records of this species in recent years since I discovered in 1972 that these pelagic kleptoparasites accompany the annual post-breeding dispersal of Brown-winged Terns (*Sterna anaethetus*) along the west coast of Sri Lanka, which usually takes place in August or September (CBCN 1972: 42 et subseq.).

455. **Blackheaded Gull** (*Larus ridibundus ridibundus*).
"A sight record from Sri Lanka, November 1974".
Further sight records in December 1976 (Phillips 1978), 1981 February 6 at Talaimannar (CBCN 1981: 17), in March 1978 at Yala National Park (CBCN 1978: 13).

456. **Slenderbilled Gull** (*Larus genei*).
Sri Lanka not mentioned. A single bird was seen a few miles out of Talaimannar on the ferry crossing in September 1978 (van den Berg 1982, CBCN 1978: 50, 59a, and 1982: 7). A new record.

465. **Common Tern** (*Sterna hirundo tibetana*).
"Winter visitor to the subcontinent ... and, irregularly, Sri Lanka".
In recent years (last decade or so ) this species has been observed every winter along the coast of Colombo, every winter, and also in the South. In 1980 I discovered a breeding colony on a small bare island of coral debris off the east coast (documented by photographs of birds, nests and eggs, and measurements of eggs) (CBCN 1980: 27-29, 31-32, 39-40, 43). This is the first record of the breeding of this species in the Eurasian tropics, the nearest known sites being at the northern end of the Persian Gulf and high-altitude lakes in Tibet. May now be considered a common and regular winter visitor, probably a summer loiterer and possibly a breeding resident. The race of the breeding terns has not been determined, but could possibly be *S. h. hirundo*.

466. **Roseate Tern** (*Sterna dougallii korustes*).
"Breeds on islets off the coast of ... Sri Lanka".
This species is not present in Sri Lanka during the winter months (except for possible loiterers not noted so far), and migrates to Sri Lanka for breeding in April/May/June.

474. **Sooty Tern** (*Sterna fuscata nubilosa*).
Sri Lanka not mentioned. Occasional straggler to all coasts, and stormblown even far inland high in the hills. Some also form part of the annual mass migration along the west coast of Brown-winged Terns first reported by me in 1972, and regularly observed since.

479. **Lesser Crested Tern** (*Sterna bengalensis bengalensis*).
"Occurs commonly along the seaboard of Pakistan, India, Sri Lanka ... practically throughout the year. Keeps to offshore waters".
Regularly seen in winter on rocks off the seashore at Colombo (and elsewhere), together with other species of terns, December to March, when it disappears after moulting into summer plumage.

480. **Sandwich Tern** (*Sterna sandvicensis sandvicensis*).
Sri Lanka not mentioned. Evidence of this species in Sri Lanka was first obtained in 1977 (CBCN 1978: 50). Since then single birds have been noted in winter almost every year till 1986 when 6 birds spent 2 months together with other terns on rocks on the coast at Colombo, and 3 in 1987 (from mid-January to beginning of April). This tern may now be considered a regular winter visitor (from the Caspian Sea) in small numbers; most seem first-year birds.

482. **Whitecapped Noddy** (*Anous tenuirostris*).
Sri Lanka not mentioned. There are 3 specimens from Sri Lanka in the Colombo Museum. A new record.

505. **Ceylon Yellow-legged Green Pigeon** (*Treron phoenicoptera phillipsi*).
"Resident. Sri Lanka in the low-country dry zone".
Very restricted and localized, mostly known from around Bibile and Nilgala, west of Gal Oya National Park in the eastern foothills.

578. **Cuckoo** (*Cuculus canorus canorus*).
"The 2 records from Sri Lanka are from October (one) and undated (one)".
Actually there are 6 records, all during the winter period, the last two in December in the south of the island (Phillips 1978).

599. **Red-faced Malkoha** (*Phaenicophaeus pyrrhocephalus*).
"Resident. Southern Kerala, southern Tamil Nadu and Sri Lanka".
This species is considered endemic to Sri Lanka. There are 2 south Indian sight records, one from Kerala, the other from Tamil Nadu. Until a specimen is obtained from India, Sri Lankan ornithologists including the late W. W. A. Phillips, prefer to retain the endemic status of this endangered species.

604. **Ceylon Coucal** (*Centropus chlororhynchus*).
"Resident. Sri Lanka, in humid forest of the SW country wet zone up to c. 750 m.".
This endemic species is rare, very local and declining together with its habitat.

606. **Barn Owl** (*Tyto alba stertens*).
"Also Sri Lanka in the Jaffna and Aripo districts"
Recently several have been obtained in Colombo and one in Kurunegala (CBCN), probably as a result of the extensive demolition of old buildings. Obviously more widespread than thought earlier, but still rare and endangered.

638. **Jungle Owlet** (*Glaucidium radiatum castanonotum*).
"Sri Lanka in the low-country wet zone and hills up to *c*. 1900 m. In moist forest".
There is evidence that this endemic race, called the Chestnut-backed Owlet, is not confined to the wet zone with moist forest, but is found in the dry zone as well, e.g. recent records from Amparai, east coast, Wilpattu National Park, Yala National Park (CBCN 1987: 4). Some writers regard it as a separate species.

727. **Threetoed Kingfisher** (*Ceyx erithacus erithacus*).
"Affects shady jungle streamlets in moist-deciduous and evergreen biotope".
In Sri Lanka now most often found in village gardens, especially coffee groves very close to habitations even in thickly populated areas, e.g. the wider area of Ratnapura. Dashes across roads only a foot or so above ground, resulting in casualties from motor traffic.

739. **Blackcapped Kingfisher** (*Halcyon pileata*).
"Resident ... Occasional inland ... and in Sri Lanka (a half-dozen records)".
This Kingfisher is an irregular winter visitor in small numbers to the coasts of Sri Lanka and has been observed more often in recent years. In some winters it is quite numerous (e.g. 1984/85), absent in others.

744. **Chestnutheaded Bee-eater** (*Merops leschenaulti*).
"Frequents the neighbourhood of streams in mixed deciduous forest ... in Sri Lanka to 1200 m.".
In Sri Lanka often found in tea plantations up to 1400 m. and above.

760. **Broadbilled Roller** (*Eurystomus orientalis irisi*).
"Resident, perhaps extinct, Sri Lanka in the southern half. Known only from a dozen records, the last in 1950".
I would be inclined to doubt the existence of a Sri Lankan subspecies which is based mainly on a slight difference in wing length in 6 South Indian and 5 Sri Lankan specimens. In recent years the bird has been rediscovered in its real habitat, the wet evergreen forest of the south-western foothills, e.g. Sinharaja, Kitulgala, Gilimale, Hapugastenna, where it favours open clearings with standing dead trees resulting from shifting culti-

vation. It is rare but certainly not extinct. There have been many sight records during the last decade. The records referred to in the SYNOPSIS are mostly from an isolated population in riverine habitat in the eastern dry zone.

808. **Little Scalybellied Green Woodpecker** (*Picus myrmecophoneus*).
"Resident ... Sri Lanka. In semi-evergreen, moist deciduous and sal forest, in plains and foothills up to 1700 m".
In Sri Lanka often frequents tea estates with shade trees in the eastern hill zone; often descends to ground and cover of tea. Not in wet zone.

817. **Small Yellownaped Woodpecker** (*Picus chlorolophus wellsi*).
"Resident. Sri Lanka in the low-country wet zone and foothills up to *c.* 1800 m".
Also found in well-shaded tea estates and forest in the Uva plateau (dry zone hills around 1000 m).

822. **Ceylon Goldenbacked Woodpecker** (*Dinopium benghalense jaffnense*).
"Resident. The Jaffna Peninsula and northern Sri Lanka south to Trincomalee, Kekirawa and Puttalam (intergrading with psarodes)".

823. **Ceylon Redbacked Woodpecker** (*Dinopium benghalense psarodes*
"Resident. Sri Lanka from Puttalam, Kekirawa and Trincomalee southwards, in low-country and hills up to 1700 m".
The area of overlap between these two endemic races has widened considerably and the boundaries are no longer as definite as the text indicates. Redbacked Woodpeckers have regularly been seen deep in Wilpattu, 30-50 miles further north, and the Goldenbacked has been observed as far south as Chilaw, with hybrids at either extreme.

859. **Blackbacked Woodpecker** (*Chrysocolaptes festivus tantus*).
"Resident. The northern half of Sri Lanka and the Southern Province, in the low-country dry zone".
Very local in isolated coconut groves and stands of large trees. Declining.

872. **Singing Bush Lark** (*Mirafra javanica cantillans*).
"Resident ... and Sri Lanka".
This species is not known in Sri Lanka.

910. **Collared Sand Martin** (*Riparia riparia*, probably *diluta* but *ijimae* also possible).
Sri Lanka not mentioned. First noted in January 1976 near Anuradhapura. Since then increasingly seen, especially in the south around Hambantota. Must now be regarded as a regular winter visitor in small (but increasing ?) numbers (CBCN). A new record.

933. **Grey Shrike** (*Lanius excubitor lahtora*).
"... an unconfirmed sight record from Sri Lanka".
There have been several reliable sight records in recent years during the winter months, mostly from the northern half of the country, but also from Yala National Park, Horton Plains (2100 m) and Colombo (CBCN). Appears to have become a regular winter visitor to all zones.

947. **Rufousbacked Shrike** (*Lanius schach caniceps*).
"Resident ... Sri Lanka in the Jaffna Peninsula".
The restricted range of this Shrike goes far beyond the Jaffna Peninsula and includes a coastal strip extending from about Chilaw through Mannar to Jaffna and the western offshore islands. Since 1966 it has also been regularly observed at Anuradhapura, well inland (CBCN).

949. **Brown Shrike** (*Lanius cristatus cristatus*).
"In dry deciduous and semi-evergreen scrub".
In Sri Lanka this winter visitor may be seen in all parts of the country up to altitudes of over 2000 m and habitats which include tea estates, where it is common.

953. **Golden Oriole** (*Oriolus oriolus kundoo*).
"Winter visitor throughout the peninsula ... also northern Sri Lanka".
This scarce winter visitor may be seen anywhere in the low-country of Sri Lanka, right down to the extreme south, at Colombo, Sigiriya, etc. (CBCN).

988. **Greyheaded Myna** (*Sturnus malabaricus blythii*).
Sri Lanka not mentioned. First tentative sight record June 1944 at Colombo ('Loris' III (5): 191). First definite sight record in Sri Lanka from Anuradhapura in January 1984 (CBCN 1984: 1). Small flocks regularly seen there since then. Probably now breeding. Recently also seen at Kalametiya in the far south in the company of Mynas, Rosy Pastors and Brahminy Mynas (CBCN). A new record.

993. **Ceylon Whiteheaded Starling** (*Sturnus senex*).
"Affects tall forest edges and clearings".
This endemic species is mainly found in undisturbed, wet evergreen forest, in the upper canopy of tall trees (e.g. Sinharaja); it is most easily seen at the edges of such forest.

1223. **Ceylon Rufousbellied (Whitethroated) Babbler** (*Dumetia hyperythra phillipsi*).
"In scrub and high grassland".
In Sri Lanka also common in well shaded tea estates.

1407. **Brown Flycatcher** (*Muscicapa latirostris*).
".... to *c*. 1500 m".
This winter visitor can be found up to 2000 m as also the next species, the Brownbreasted Flycatcher (*M. muttui*).

1505. **Franklin's Wren-Warbler** (*Prinia hodgsonii pectoralis*).
"... up to 900 m".
This Sri Lankan subspecies now ascends the hills in the eastern aspects (Uva) to *c*. 1400 m.

1706. **Isabelline Chat** (*Oenanthe isabellina*).
"Straggling to ... and Sri Lanka, recorded on passage Mannar 1970".
Two sight records in 1970 and 1976, both near Mannar (CBCN 1976: 12). It is now believed that both these sightings were of the Pied Chat or Wheatear (*Oenanthe pleschanka* ) No. 1715 (Ceylon Bird Club Rarities Committee).

1710. **Desert Wheatear** (*Oenanthe deserti*).
Sri Lanka not mentioned. A reliable sight record in February from Yala in the extreme South (CBCN 1986: 22). A new record.

1838. **Velvetfronted Nuthatch** (*Sitta frontalis frontalis*).
"... and Sri Lanka ... shade trees in coffee or cardamom plantations".
In Sri Lanka also common on shade trees in tea plantations and dense montane forest.

1852. **Indian Tree Pipit** (*Anthus hodgsoni hodgsoni*).
Sri Lanka not mentioned. In January 1982 Robert Fleming, Jr. reported a flock from Anuradhapura (CBCN 1982: 1). Sight record only. Two more sightings since then in Wilpattu National Park (CBCN 1984: 17 and 1987: 30). A new record.

1885. **White Wagtail** (*Motacilla alba dukhunensis*).
"... occasional in Sri Lanka". This bird has become a regular winter visitor in small numbers. There are sight records from many parts of the low-country (CBCN).

1891. **Large Pied Wagtail** (*Motacilla maderaspatensis*).
"One old record from Sri Lanka".
There have been 3 additional, very reliable sight records: Kandy (CBCN 1976: 77), Delft Island (CBCN) 1983: 4), Punkudutivu Island (CBCN 1984: 2).

1893. **Ceylon Thickbilled Flowerpecker** (*Dicaeum agile zeylonense*).
"Resident in Sri Lanka, in the northern forest tracts and in the hills to *c*. 1200 m".
This Sri Lankan subspecies is most plentiful in the eastern forest tracts (e.g. Gal Oya National Park, Amparai) and also the foothills of the central range in the dry and intermediate zone.

## ACKNOWLEDGEMENT

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# THE PITCHER PLANT (*NEPENTHES KHASIANA* HK.F.) SANCTUARY OF JAINTIA HILLS, MEGHALAYA: LESSONS FOR CONSERVATION[1]

W. A. Rodgers and Sangeeta Gupta[2]

(*With a text-figure*)

Details of the biology and distribution of the pitcher plant *Nepenthes khasiana* Hk. f. are described, and the conservation importance of the plant which is considered an endangered endemic is discussed. The initiative of the Jaintia Hills District Council in setting up a pitcher plant sanctuary at Jarain in 1974 is commended and the area and forest cover are briefly described. The sanctuary has declined in conservation status over the past decade and it is concluded that further inputs from State Government and Conservation Agencies will be required to maintain a viable level of protection.

## INTRODUCTION

Meghalaya has long been known to have an extremely rich flora (e.g. Hooker 1896). Recently increasing concern has been expressed over problems of conserving this important but endangered resource. For example, seven papers in a major symposium volume, "An Assessment of Threatened Plants of India" (Jain & Rao 1983) deal with Meghalaya. In addition, three recent floras of Meghalaya (Bala Krishnan 1981, Joseph 1982 and Haridasan & Rao 1985) all stress the increasing level of deforestation which endangers the rare and endemic plant species of the region. Most authors mention a particular species, *Nepenthes khasiana* Hk. f., the only Indian representative of a small family of insect-digesting pitcher plants, the Nepenthaceae, as an example of conservation needs. The pitcher plant as a focus of concern is attaining the same significance in botanical circles as the tiger has through "Project Tiger', a major and successful ecosytem conservation project in India.

Most authors discussing in-situ conservation of plant resources in Meghalaya are botanists, and whilst their papers detail the problems and the species involved, rarely do they discuss practical and definitive measures for conservation. For conservation to succeed, areas of land containing the species must be protected. All too rarely are we given details of "where" conservation should or could take place.

Patterns of land ownership in Meghalaya do not help established methods of conservation in India, where selected forest reserves are upgraded to sanctuaries and parks. In Meghalaya only 3% of the land area is state controlled forest, the remaining forest, over 34% of the state, is controlled by the District Councils, local villages and clans and by private individuals. True, the state can purchase such land, as was done in January 1986 when the 220 sq kms Balphakram National Parks was purchased for over four crore rupees; this is a long and expensive process.

It is thus of interest to report on a conservation measure taken by the initiative of a district council, which specifically protects a major population of the pitcher plant.

**The Pitcher Plant:** The family Nepenthaceae has two genera, *Anurosperma* of Seychelles, and *Nepenthes* with 67 species in Madagascar, Sri Lanka, India, Burma, China, Malaysia, Indo China to North Australia. *N. khasiana* is the only representative in India, and is found only in Meghalaya state.

*N. khasiana* is a perennial herb, which may become partially lignified, it inhabits boggy areas from 500-2000 m above sea level in the southern half of Meghalaya. Plants may climb on trees at forest edges to reach some 8 m in height, or may remain as herbs in grassland where they are frequently burnt by wild fires, but regenerate rapidly from the root stock. They prefer sunlight, and are rarely seen in dense shade. Its recorded distribution is shown in Fig. 1.

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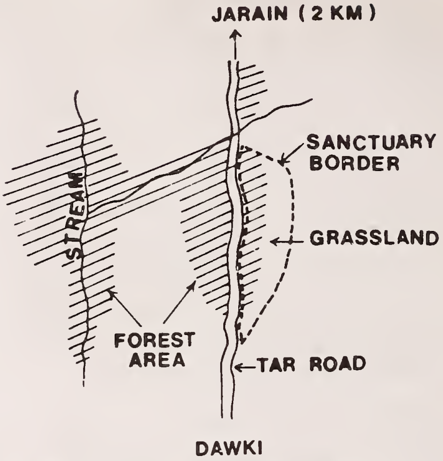
[1] Accepted May 1987.

[2] Wildlife Institute of India, Dehra Dun - 248006 (India).

MAP OF INDIA
SHOWING MEGHALAYA


JARAIN (2 KM)
SANCTUARY BORDER
STREAM
GRASSLAND
FOREST AREA
TAR ROAD
DAWKI

SKETCH MAP OF PITCHER
PLANT SANCTUARY JARAIN

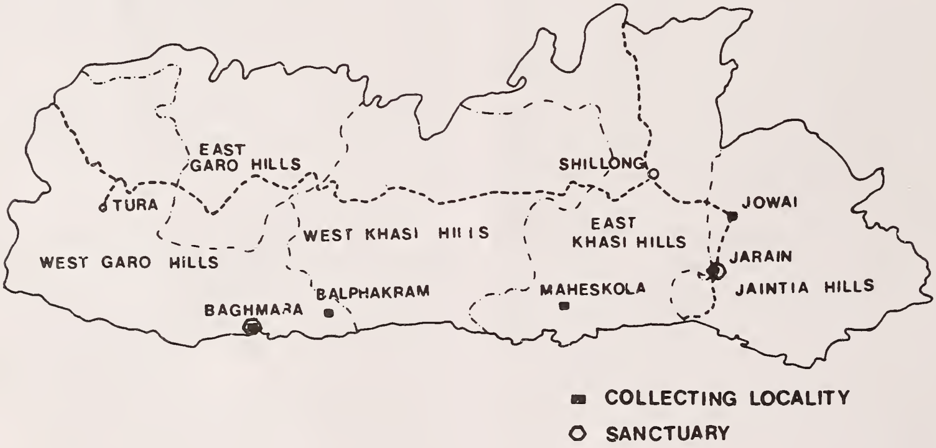

EAST GARO HILLS
TURA
WEST GARO HILLS
WEST KHASI HILLS
BALPHAKRAM
BAGHMARA
SHILLONG
EAST KHASI HILLS
MAHESKOLA
JOWAI
JARAIN
JAINTIA HILLS
■ COLLECTING LOCALITY
○ SANCTUARY

DIAGRAM SHOWING DISTRIBUTION OF N. KHASIANA AND
LOCATION OF THE PITCHER PLANT SANCTUARY.

**The Pitcher Plant Sanctuary:** In 1974, the Jaintia Hills District Council declared some 2.45 ha of district council forest near Jarain to be a 'pitcher plant sanctuary'. This was probably in response to the national mood of conservation prevailing at that time (pers. comm. Chief Forest Officer, Jaintia). The 'sanctuary' which has been declared under District Council rules is not a Wildlife Sanctuary under the Indian Wildlife or Forest Acts; its precise legal status remains obscure, but can be a planning or management unit of the council forest reserve, a unit which will not be permitted to be logged or exploited. There is another pitcher plant sanctuary, Baghamara Wildlife Sanctuary in Garo Hills, which is legally constituted under the Wildlife Act, but it is a very small in area, and has no permanent conservation input and is of uncertain viability. The Jarain sanctuary is situated alongside the black top district road to Dawki, some 2 km south of Jarain (see Figs. 1 & 2). The area is a mosaic of frequently burnt and grazed grassland with patches of *Quercus* in subtropical wet hill forest [Champion and Seth (1968) category, 8B/C2]. The forests of Jarain contain several other rare and endemic species, e.g. *Arundinaria mannii, Daphne shillongi, Pteracanthus nobilis,* (Gupta and Rodgers, unpublished information). The sanctuary was fenced with multiple strand barbed wire, to demarcate the area and keep out cattle. A gate leads to a bricked raised path which winds through the forest and grassland. The area is elongated north to south and has a small patch of wet grassland on the eastern boundary, with several seepages along the forest edge.

The present status indicates considerable deterioration since the time of its establishment in 1974. The fence is damaged in many places and cattle do enter both the grassland and the forest (no browse sign was seen on *Nepenthes).* All the grassland has been burnt, but this is typical of the region and may not harm the pitcher population. The brickwork was damaged and the signposts had gone. There were frequent signs of small timber, pole and firewood cutting in the forest. However, the first author counted over 100 pitcher plants in a two hour visit, and more were seen in neighbouring forest patches.

As neither this sanctuary nor the forest type has previously been described in the literature, the opportunity is taken to do so briefly here, based on rapid field surveys in early February (W.A.R.) and June (S.G.) 1986 (A plant list is given in Appendix 1).

1) The grassland is dominated by *Cymbopogon* sp. up to 1.2 m, with *Cyperus, Chrysopogon, Juncus* and *Themeda* spp. *Lycopodium cernuum* is common as is the colourful woody shrub *Melastoma normale. Nepenthes* plants up to 0.7 m high, are scattered in this grassland. The area is on gentle slopes, with several boggy seepages.
2) The forest tree layer is to 10 m with a continuous evergreen dense crowned canopy. No internal strata were recognizable. Lianes and epiphytic orchids were present but not common, epiphytic ferns were rare at the times of our visits. The canopy is species rich, and includes *Castanopsis indica, Engelhardtia spicata, Eugenia* sp., *Exbucklandia populnea, Helicia erratica, Lindera* spp., *Litsaea salcifolia, Machilus odoratissima, Manglietia insignis, Quercus spicata* (abundant), *Q. griffithii, Schefflera hypoleuca* and *Schima wallichii. Alseodaphne petiolaris* and *Myrica esculenta* were common on the forest edge.
3) The underwood and shrub layers have smaller individuals of canopy species plus *Alchornea* sp., *Ardisia undulata, Camellia drupifera, Cinnamomum* spp., *Eurya* spp., *Goniothalamus sesquipedalis, Mahonia pycnophylla, Randia spinosa* and *Symplocos* spp. Tangles of *Rubus, Smilax* and *Embelia* are common. Shrub cover is variable, but often opened due to cutting.
4) The forest floor has a mat of *Selaginella* and other species with occasional large woody ferns, *Blechnum orientale,* up to 2 m. There are small patches of *Thysanolaena* and a bamboo. Small sedges and herbs fill gaps on the floor.

The forest gives an overall impression of floristic diversity, there being little apparent dominance in any layer.

## DISCUSSION

It is apparent that an enthusiastic local District council conservation initiative has deteriorated due to lack of interest. The councils are short of funds and staff, and have not been able to maintain sacred status of the sanctuary. They now wish the State Government to share this responsibility (pers. comm. CFO, Jaintia). Visitors have been few, response from State and Central Government has been minimal, and no positive feed back or encouragement has reached either the Council or the local villagers. It is natural that conservation interest wanes in such circumstances. Baghmara W.L.S. and Balphakram National Park (which also has a pitcher plant population) are both low altitude tropical evergreen forest areas, protecting very different communities from those described here.

The pitcher plant population still survives, and is probably robust enough to withstand some more burning and cutting and grazing. But the forest community itself is not so robust, wood cutting is causing damage, and the forest will be losing its protective structure, diversity and regneration. The sanctuary was designed for one species, but does safeguard a community not protected elsewhere in India. There are no other sanctuaries in Jaintia and the tiny sacred groves of Jaintia Hills, possibly as many as 200 averaging less than 1 ha in size (pers. comm. CFO, Jaintia), are not demarcated and are being over-exploited (Rodgers, unpublished data). They cannot function as long term conservation areas.

The pitcher plant sanctuary is important therefore, nationally as well as locally; the question is how best to protect it. It is our hope that there will be eventually a network of several small protected areas in Meghalaya, specifically conserving rare plant values, e.g. proposals under the Government of India Biogeography Project, see Lahiri Choudhury (1986). This sanctuary will be one of them. It is not possible to visualise them all being protected by State government employees. We would like to see the State Government assist the district council to manage the area, by provision of funds to maintain structures and employ care-takers from Jarain village. The State Forest Department is assisting the District Council in this regard from 1987 (pers. comm. Chief Wildlife Warden, Shillong). The State Forest or Wildlife wing could detail an officer to make regular tours of inspection of this and other such areas. Above all, the State government and conservation organisations should encourage such local conservation efforts.

Appendix 1 gives a partial plant list for the sanctuary. This is based on collections made at the sanctuary and later identified in Dehra Dun by Dr. P. K. Hajra of B.S.I. Dehra Dun , and on plants identified at the site by B.S.I. Shillong. This list is NOT complete, but serves as an indication of the floristics of this community. Plants are listed in alphabetical order.

## ACKNOWLEDGEMENTS

We thank the Wildlife Wing of the Forest Department of Meghalaya for facilitating our visits and Shri Wahlang, Chief Wildlife Warden, Meghalaya, for commenting on an earlier draft of this paper. The Botanical Survey of India, Shillong discussed Jarain forests and Shri Shankar Das acompanied us in the field. Forest Range Office Jowai gave hospitality. Dr. P.K. Hajra discussed plant identifications at Dehra Dun. Shri Rajesh Thapa patiently word processed the many drafts in various stages including the final one. Miss Asha Jain drew diagrams. S.G acknowledges permission of the Director of the Wildlife Institute of India to publish this paper.

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## APPENDIX I

### PARTIAL PLANT LIST FOR JARAIN PITCHER PLANT SANCTUARY

| Family | Genus, Species and Authority |
|---|---|
| | DICOTYLEDONS |
| ANNONACEAE | *Goniothalamus sesquipedalis* Hk. f. and Th.* |
| ARACEAE | *Raphidophora* sp. |
| ARALIACEAE | *Schefflera hypoleuca* Kurz. |
| BEGONIACEAE | *Begonia picta* Sm. |
| BERBERIDACEAE | *Mahonia pycnophylla* (Fedde)Takeda |
| DROSERACEAE | *Drosera peltata* Smith |
| EUPHORBIACEAE | *Alchornea* sp. |
| FAGACEAE | *Castanopsis indica* A.DC.* |
| | *Quercus griffithii* Hk.f. and Th.* |
| | *Q. spicata* Smith |
| HAMAMELIDACEAE | *Exbucklandia populnea* (Griff.) R.Br.* |
| JUGLANDIACEAE | *Engelhardtia spicata* Blume |
| JUNCACEAE | *Juncus* sp. |
| LAURACEAE | *Alseodaphne petiolaris* Hk.f. |
| | *Cinnamomum* sp. |
| | *Lindera melastomacea* Benth.* |
| | *L. pulcherrima* Benth. |
| | *Litsaea salicifolia* Roxb. |
| | *Machilus odoratissima* Nees |
| MAGNOLIACEAE | *Manglietia insignis* (Wall.) Blume* |
| MELASTOMACEAE | *Melastoma normale* D.Don* |
| MYRICACEAE | *Myrica esculenta* Buch.-Ham. |
| MYRSINACEAE | *Ardisia undulata* Clarke |
| | *Embelia floribunda* Wall. |
| MYRTACEAE | *Eugenia* sp. |
| PROTEACEAE | *Helicia erratica* Hk.f.* |
| ROSACEAE | *Rubus ellipticus* Sm. |
| RUBIACEAE | *Mussaenda frondosa* L. |
| | *Randia spinosa* (Thunb.) Poir |
| SYMPLOCACEAE | *Symplocos spicata* Thunb. |
| | *Symplocos* sp. |
| TERNSTROEMACEAE | *Cammelia drupifera* Lour.* |
| THEACEAE | *Eurya acuminata* DC.* |
| | *E. japonica* Thunb.* |
| | *Schima wallichii* (DC.) Korth.* |
| | MONOCOTYLEDONS |
| CYPERACEAE | *Cyperus* spp. |
| GRAMINEAE | *Chrysopogon* sp. |
| | *Cymbopogon* sp. |
| | *Dendrocalamus* sp. |
| | *Themeda* sp. |
| | *Thysanolaena maxima* Nees |
| LILIACEAE | *Smilax aspera* L. |
| ORCHIADACEA | *Dendrobium amoenum* Wall.* |
| | *Pholidota pallida* Lindl.* |
| | PTERIDOPHYTA |
| | *Blechnum orientale* L. |
| | *Dicranopteris linearis* (Burm.f.) Underwood<br>(=*Gleichenia linearis*) |
| | *Lycopodium cernuum* L. |
| | *Selaginella bisulcata* Spring |

# FOOD SPECTRUM OF THE MARBLED TOAD, *BUFO STOMATICUS* LUTKEN[1]

S.K. BATTISH, ANNU AGARWAL AND PARAMJIT SINGH[2]

The paper presents a detailed food spectrum of *Bufo stomaticus*, the commonest species of toad in Punjab. The observations made on the gut contents of this animal from May to October 1985 revealed the presence of insects (70 families), spiders, centipedes, molluscs, plant materials, debris, mud and stone pieces. It is concluded that the toad is primarily insectivorous.

## INTRODUCTION

*Bufo stomaticus* though a common species of Anura in Punjab has not yet been investigated for its food and feeding habits. In the present paper the quality and quantity of the food of this toad, based upon gut content analysis, is presented.

## MATERIAL AND METHODS

The stomach content analysis of *Bufo stomaticus* was carried out during May to October, 1985. The toads were collected during dusk and before dawn when they leave their hideouts. The toads were killed instantly after collection by putting 20 ml of chloroform in the plastic bucket with lid containing the animals, and 6 ml of 5% formalin solution was injected in the stomach of each so as to preserve the organ and to stop the mixing of gastric juice with the food. In the laboratory the stomach of each specimen was removed and stored in 70% ethanol. For the investigations, stomach contents were taken out in a petridish in alcohol after incising the stomach longitudinally. The contents were examined under a binocular dissecting microscope (18, 8x). The contents were separated into two groups (i) whole or almost whole insects, insect fragments namely, head capsules, dissociated legs, sclerites, wings, elytra, ovipositors etc. (ii) other items namely, fragments of spiders, centipedes, earthworms, mollusca, pebbles and plant matter. Using diagnostic taxonomic characters the food contents of the first category were identified.

## RESULTS

The monthly distribution of the food items recorded from the guts of *Bufo stomaticus* during May to October 1985 is shown in Table 1. It is seen that the toads primary food is insects but other animals like spiders, centipedes, earthworms and molluscs are also eaten. Some percentage of the food is comprised of plant matter and even pebbles. The consumption of insects per toad (Table 1) is high in the months May to July (26-28) but declines in August (16). The toad fed on a variety of insects belonging to 70 families of 14 orders. The most predominant insect orders were Coleoptera and Heteroptera which constitute the main food in terms of varieties of insects captured by *Bufo stomaticus*. The data (Table 1) further indicates that except Hymenoptera, other predominant orders were phytophagous insect pests, i.e. Coleoptara, Heteroptera, Lepidoptera, Homoptera and Orthoptera constituting 28, 10, 5, 5 and 4 families respectively.

The toad fed mainly on Hymenoptera (ants, Myrmicinae and Formicinae), Diptera (mosquitoes) and Coleptera (beetles) during the month of May. Phytophagous pests viz. Anthocoridae (flower bugs), Lygaeidae (dusky cotton bug), Elateridae (click beetles), Chrysomelidae (red pumpkin beetles) and Noctuidae (army worms and *Heliothis* larvae) were also recovered from the stomachs of *Bufo stomaticus* during May, 1985.

During June-July 1985 (Table 1) the most predominant food items of this animal were Isoptera (termites) and Hymenoptera (ants, Myrmicinae and Formicinae). Amongst the phytophagous pests, Pyrrhocoridae (red cotton bug), Cicadellidae (leaf hoppers particularly cotton jassids and mango hoppers), Fulgoridae (plant hoppers mainly *Pyrilla)*, Psyllidae (jumping plant lice mainly *Citrus psylla*), Carabidae (ground beetles), Dermestidae (carpet beetles), Elateridae (click beetles), Psephenidae (water- penny beetles), Tenebrionidae

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[1] Accepted August 1987.

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(darkling beetles), Scarabaeidae (scarab beetles), Chrysomelidae (mainly red pumpkin beetles), Curculionidae (snout beetles), Noctuidae (army worm and heliothis larvae) and Pyraustidae (cotton leaf roller) were also fed on by *Bufo stomaticus,* indicating that this toad may be useful for control of phytophagous pests. However, during this period (June- July 1985) they also fed on parasites and predators, namely braconids, trichogrammatids, sphecids, chalcids and ichneumonids in tangible amounts.

Hymenoptera (ants, Myrmicinae and Formicinae) were again the major food items of *Bufo stomaticus* during August-September 1985 (Table 1). In addition, Cicadellidae (leaf hoppers mainly cotton jassids and mango hoppers), Fulgoridae (plant hopper namely the *Pyrilla),* Dytiscidae (predaceous diving beetles), Telegeusidae (telegeusid beetles), Pselaphidae (short-winged mould beetles), Dermestidae (carpet beetles), Chrysomelidae (mainly red pumpkin beetles), Pieridae (cabbage caterpillar) and Diptera (mosquitoes) were present in large numbers.

TABLE 1

PERCENT OF FOOD ITEMS RECOVERED FROM THE STOMACH OF *Bufo Stomaticus* DURING MAY TO OCTOBER, 1985

| | | May | June | July | August | September | October |
|---|---|---|---|---|---|---|---|
| Total number of toads examined | | 27 | 51 | 46 | 30 | 21 | 16 |
| Total number of prey eaten | | 689 | 1423 | 1263 | 467 | 368 | 152 |
| Number of prey eaten per toad | | 26 | 28 | 27 | 16 | 18 | 10 |
| Empty stomachs | | 3.70 | 9.80 | 0 | 13.33 | 0 | 25.0 |
| Stomachs containing pebbles | | 3.70 | 25.49 | 19.57 | 16.66 | 19.05 | 12.50 |
| Stomachs containing plant matter | | 37.0 | 29.41 | 34.78 | 26.66 | 33.33 | 31.25 |
| Stomachs containing insects | | 96.29 | 90.19 | 100 | 86.66 | 100 | 75.0 |
| Insect Order | Family/Name of the insect | | | | | | |
| 1. Thysanura | Machilidae (Bristle tail (arvae) | — | — | 0.396 | — | — | — |
| 2. Diplura | | — | 0.070 | — | — | — | — |
| 3. Collembola (Spring tails) | | 0.145 | 0.70 | — | — | — | — |
| 4. Orthoptera | i) Tridactylidae (Pygmy mole-cricket) | — | 0.141 | — | 0.428 | 0.815 | — |
| | ii) Acrididae (Shorthorned grasshoppers) | 0.145 | 0.070 | 0.158 | 0.214 | — | — |
| | iii) Tettigonidae (Long horned grasshoppers and Katydids) | — | 0.703 | 0.079 | 0.428 | 0.272 | 0.658 |
| | iv) Gryllidae (Crickets) | — | — | 0.428 | 0.079 | 0.815 | 1.316 |
| 5. Isoptera (Termites) | | — | 17.569 | 26.840 | — | — | — |
| 6. Dermaptera (Earwigs) | | 0.871 | — | 0.870 | 1.499 | 0.815 | — |
| 7. Mallophaga (Chewing lice) | | — | 0.070 | 0.079 | — | — | — |

| Insect Order | Family/Name of the insect | May | June | July | August | September | October |
|---|---|---|---|---|---|---|---|
| 8. Thysanoptera (Thrips) | | 0.145 | — | — | — | — | — |
| 9. Hemiptera | | | | | | | |
| a) Heteroptera | | | | | | | |
| | i) Corixidae (Water boatman) | — | — | — | 0.214 | — | — |
| | ii) Notonectidae (*Notonecta*) | — | — | — | 0.428 | 1.085 | — |
| | iii) Anthocoridae (Flower bug) | 1.306 | — | — | — | — | — |
| | iv) Ploiaridae (Thread legged bug) | — | — | — | 0.214 | — | — |
| | v) Lygaeidae (Dusky cotton bugs) | 0.871 | 0.141 | — | 0.857 | 0.658 | — |
| | vi) Pyrrhocoridae (Red cotton bugs) | 0.435 | 0.914 | — | — | — | — |
| | vii) Cimicidae (Bed bugs) | 0.145 | — | — | — | — | — |
| | viii) Coreidae (Rice bugs) | 0.145 | — | 0.238 | 0.214 | 0.543 | — |
| | ix) Podopidae (Terrestrial turtle bugs) | — | — | — | 0.214 | — | — |
| | x) Pentatomidae (Stink bugs) | — | — | 0.158 | 0.428 | 0.272 | 1.316 |
| | xi) Others | 0.290 | — | — | — | — | — |
| b) Homoptera | | | | | | | |
| | i) Cicadidae (Cicadas) | — | — | 0.079 | — | — | — |
| | ii) Cicadellidae (Leafhoppers) | 0.290 | 0.141 | 2.059 | 2.998 | 0.543 | 1.974 |
| | iii) Fulgoridae (Plant hoppers) | — | 0.211 | 0.633 | 1.285 | 2.446 | 2.632 |
| | iv) Delphacidae (Plant hoppers) | — | — | — | — | 0.815 | — |
| | v) Psyllidae (Jumping Plant lice) | — | — | — | — | 0.815 | — |
| 10. Coleoptera | i) Physodidae (Wrinkled bark beetles) | 0.145 | — | — | — | — | — |
| | ii) Cicindelidae (Tiger beetles) | 0.290 | — | 0.238 | — | — | — |
| | iii) Carobidae (Ground beetle) | 0.290 | 0.281 | 2.375 | — | — | — |
| | iv) Gyrinidae (Whirligig beetle) | — | 0.141 | — | 0.214 | — | — |

| Insect Order | Family/Name of the insect | May | June | July | August | September | October |
|---|---|---|---|---|---|---|---|
| | v) Dytiscidae (Predaceous diving beetle) | — | — | 0.079 | 6.209 | 6.521 | — |
| | vi) Telegeusidae (Telegeused beetles) | — | — | — | — | 11.413 | 2.632 |
| | vii) Histeridae (Hister beetles) | — | 0.703 | — | — | — | — |
| | viii) Scaphididae (Shining fungus beetles) | — | 0.703 | — | — | — | — |
| | ix) Pselaphidae (Short winged mold beetles) | — | — | 0.475 | 0.642 | 5.706 | 1.316 |
| | x) Cantharidae (Soldier beetles) | — | — | — | 0.214 | — | – |
| | xi) Dermestoidae (Carpet beetles) | 0.145 | 0.422 | 0.554 | 3.426 | 0.543 | 1.974 |
| | xii) Ostomidae (Bark growing beetles) | — | — | 0.158 | — | 0.272 | 0.658 |
| | xiii) Cleridae (Checkered beetle) | — | – | 0.158 | — | 3.533 | 1.316 |
| | xiv) Sandalidae (Sandalid beetles) | — | — | 0.238 | — | — | — |
| | xv) Elasteridae (Click beetles) | 0.725 | — | 1.092 | 5.996 | 0.815 | 1.316 |
| | xvi) Psephenidae (Water penny beetles) | — | 1.124 | 1.188 | — | 2.174 | — |
| | xvii) Lathridiidae (Monoedid beetles) | 0.290 | — | — | — | — | — |
| | xviii) Coccinellidae (Spotted beetles) | 0.290 | 0.351 | 0.079 | 1.713 | — | — |
| | xix) Tenebrionidae (Darkling beetles) | 0.145 | 1.757 | 1.029 | 0.857 | — | — |
| | xx) Psoidae (Twig beetles) | — | — | — | — | 0.543 | 0.658 |
| | xxi) Passalidae | 0.290 | — | — | — | — | — |
| | xxii) Scarabaeidae (Scarab beetles) | 0.435 | 1.124 | 3.802 | 1.285 | 1.087 | 1.316 |
| | xxiii) Cerambycidae (Wood boring beetles) | 0.145 | — | 0.396 | — | — | — |
| | xxiv) Chrysomelidae (Red pumpking beetles) | 1.016 | 0.422 | 1.029 | 1.927 | 1.087 | — |
| | xxv) Bruchidae (Seed beetles) | — | — | 0.079 | — | 0.272 | — |

| Insect Order | Family/Name of the insect | May | June | July | August | September | October |
|---|---|---|---|---|---|---|---|
| | xxvi) Circulionidae (Snout beetles) | 0.290 | 0.351 | 0.950 | 1.070 | 1.902 | 3.947 |
| | xxvii) Platypodidae (Pinohole borers) | 0.290 | 0.070 | — | 0.214 | — | — |
| | xxviii) Scolyidae (Bark beetles) | 0.145 | — | — | 0.642 | 0.272 | — |
| | Grubs | 0.581 | 0.562 | 0.238 | 0.428 | — | — |
| | xxix) Others | 3.193 | 0.351 | 2.059 | 6.423 | 1.630 | 0.289 |
| 11. Lepidoptera | i) Gelechiidae | — | 0.070 | — | — | — | — |
| | (Pink wool worm moth), other moth | — | 0.70 | 0.158 | — | — | 1.316 |
| | ii) Noctuidae (Armyworm laraae, Heliothis larvae) | 1.306 | — | 0.475 | 0.428 | 0.543 | 1.316 |
| | iii) Arctoidae (Hairy-caterpillar) | — | 0.211 | 0.158 | — | — | — |
| | iv) Pyraustidae (Cotton leaf roller) | 0.281 | 0.079 | — | — | — | — |
| | v) Pieridae (Cabbage catter-pillar) | — | — | — | 1.285 | — | — |
| | vi) Other larvae | 0.145 | 0.492 | — | 0.428 | — | 1.316 |
| 12. Diptera | (Flies) | 0.435 | 0.070 | — | 0.428 | 0.272 | 1.316 |
| | (Mosquitoes) | 3.193 | 2.108 | 1.070 | 7.384 | — | |
| | (Maggots) | — | 0.70 | 2.692 | 0.428 | 0.815 | — |
| 13. Hymenoptera | i) Braconidae | 0.725 | 0.562 | 0.791 | 0.428 | 0.815 | 0.658 |
| | ii) Trichogrammalidae | 1.016 | 0.984 | 0.317 | 0.428 | 1.630 | 2.632 |
| | iii) Sphecidae | 1.457 | 8.451 | 1.504 | — | 1.087 | 1.316 |
| | iv) Chalcididae | — | 4.779 | 0.950 | — | — | — |
| | v) Ichneumonidae | — | 0.422 | 0.238 | 0.642 | — | — |
| | vi) Formicidae | — | 0.141 | 0.396 | — | — | 2.632 |
| Subfam. | a) Formicinae | 10.740 | 27.547 | 23.129 | 19.272 | 18.750 | 27.632 |
| | b) Ants (Myrmicinae small ants) | 66.183 | 32.959 | 22.169 | 30.835 | 21.739 | 30.263 |
| | vii) Apidae (Bees) | 0.435 | 0.141 | 0.317 | 0.428 | 2.717 | — |
| | vii) Tanthridinidae (Althalia larvae) | — | — | — | 0.214 | — | — |
| 14. Dictyoptera | (Cockroaches) | — | 0.422 | 0.633 | 1.285 | 0.272 | — |
| Arachnida (Spiders) | | 0.871 | 0.632 | 0.238 | 0.428 | 1.630 | 3.289 |
| Chilopoda (Centipedes) | | — | 0.070 | — | 0.428 | 1.630 | 3.289 |
| Annelida (Earthworms) | | — | 0.070 | — | — | — | — |
| Mollusca (Gastropid molluscans) | | — | 0.492 | 0.238 | 0.428 | — | — |

In October 1985 (Table 1) the quantity of food in the stomach was comparatively lower than the earlier months and the predominant insects identified from the guts of *B. stomaticus* were again the Hymenoptera (ants). Other major food items were Fulgoridae (plant hopper mainly the *Pyrilla),* Telegeusidae (telegeusid beetles), Curculionidae (snout beetles mainly the grey weevil), Hymenoptera (parasites mainly the trichogrammatids) and Arachnids (spiders).

## DISCUSSION

The present study has revealed that *Bufo stomaticus* fed on insects belonging to 70 families of 14 orders. The toad's capture of these insects was a chance factor. The representation of 28 families of the order Coleoptera from diverse habitats like agroecosystems, terrestrial, aquatic and arboreal also showed the affinity of this toad to such environments. Further, it also indicates *B. stomaticus* to be primarily insectivorous and no cannibalism was reported during the study period. However, Boulenger (1897) and Noble (1918) reported frogs & toads to be carnivorous and cannibalistic. The seasonal dietary requirements of the toad varied (Table 1). The insect consumption per toad was high (26-28) in the months of May-July but low (16) in August and lowest (10) in October. The high consumption of food in May-July was because of high reproductive activity of the toad, as evident from the field study, gonadal weight and gonado-somatic index (paper on breeding of *Bufo stomaticus* in preparation). The feeding rate declined in August and September; and in October, it was

TABLE 2

PERCENTAGE OF OCCURRENCE IN THE GUT

| | May | June | July | August | September | October |
|---|---|---|---|---|---|---|
| Thysanura (Bristle tail larvae) | | | 2.17 | | | |
| Diplura | | 1.96 | | | | |
| Collembola (Spring tail) | 3.70 | | | | | |
| Orthoptera (Grasshoppers, | 3.70 | 3.92 | 6.52 | 6.67 | 4.76 | 6.25 |
| Crickets) | | 3.92 | 2.17 | 10.00 | 19.05 | 12.5 |
| Isoptera (Termites) | | 11.76 | 28.26 | | | |
| Dermaptera (Earwigs) | 11.11 | | 10.87 | 10.0 | 9.52 | |
| Mallophaga (Chewing lice) | | 1.96 | 2.17 | | | |
| Thysanoptera (Thrips) | | 1.96 | | | | |
| Heteroptera (Bugs) | 29.62 | 17.64 | 10.87 | 23.33 | 28.57 | 18.75 |
| Homoptera (Leaf/plant hoppers) | 7.40 | 5.88 | 28.26 | 46.67 | 38.09 | 12.5 |
| Coleoptera (Small grey weevil) | 66.66 | 43.13 | 71.73 | 56.67 | 85.71 | 43.75 |
| (Big grey weevil) | 55.55 | 35.29 | 45.65 | 50.00 | 57.14 | 43.75 |
| | | | 10.87 | 3.33 | 9.52 | 18.75 |
| Lepidoptera (Larvae) | 22.22 | 15.68 | 10.87 | 10.0 | 9.52 | 12.50 |
| (Moths) | | 3.92 | 2.17 | | | 12.5 |
| Diptera (Flies) | 11.11 | 1.96 | | 6.67 | 4.76 | 12.5 |
| (Mosquitoes) | 18.51 | 23.52 | | 13.33 | 19.05 | |
| (Maggots) | | 1.96 | 4.34 | 6.67 | 9.52 | |
| Hymenoptera (Parasites) | 29.52 | 33.33 | 13.04 | 10.0 | 19.05 | 12.50 |
| (Bees and wasps) | 18.52 | 15.68 | 10.87 | 10.0 | 19.05 | 6.25 |
| (Myrmicinae) | 85.19 | 66.66 | 45.65 | 46.67 | 52.38 | 62.5 |
| (Formicinae) | 62.96 | 52.94 | 50.0 | 56.67 | 57.14 | 68.75 |
| Dictyoptera (Cockroaches) | | 5.88 | 13.04 | 13.33 | 4.76 | |
| Arachnida (Spiders) | 14.81 | 13.72 | 4.34 | 6.67 | 23.81 | 25.0 |
| Chilopoda (Centipedes) | | 1.96 | | 3.33 | | |
| Annelida (Earthworms) | | 1.96 | | | | |
| Mollusca (Gastropod molluscans) | | 11.76 | 2.17 | | | |

very low because October marks the prehibernation period of the toad.

In the present study, hymenopterous ants of the sub-families Myrmicinae and Formicinae were dominant in the diet both in the percentage of prey eaten (Table 1) and the percentage of occurrence in guts (Table 2). Weber (1938) also reported the ants of family Formicidae to be the main food item in *B. marinus* and Forge and Barbault (1980) found ants and beetles to be the predominant food of *B. pentoni*.

The exact appreciation of the insect food can, however, be worked out in terms of percentage of total biomass (Tables 2, 4) consumed. Berry and Bullock (1962) and Berry (1965) measured the volume of the gut contents but have not presented it as per insect. The total biomass consumed per toad, calculated by the weighing coefficients gives the real bioefficacy of anurans as control agents.

It may thus be inferred that the feeding potential can be appreciated on the basis of weight of insect rather than percentage total number of prey as the number is not representative of the size of insects belonging to different orders.

TABLE 3

PERCENTAGE OF TOTAL BIOMASS

| Food items | May | June | July | August | September | October |
|---|---|---|---|---|---|---|
| Thysanura (Bristle tail larvae) | — | — | 0.02 | — | — | — |
| Diplura | — | 0.04 | — | — | — | — |
| Collembola (Spring tail) | 0.001 | — | — | — | — | — |
| Orthoptera (Grasshoppers, | 1.28 | 1.23 | 1.58 | 2.34 | 1.08 | 3.85 |
| Crickets) | — | 0.23 | 0.09 | 0.59 | 1.21 | 1.44 |
| Isoptera (Termites) | — | 15.94 | 18.45 | — | — | — |
| Dermaptera (Earwigs) | 4.13 | — | 3.09 | 2.92 | 1.73 | — |
| Mallophaga (Chewing lice) | — | 0.001 | 0.0008 | — | — | — |
| Thysanoptera (Thrips) | — | 0.001 | — | — | — | — |
| Heteropters (Bugs) | 15.17 | 4.96 | 1.41 | 3.77 | 4.04 | 6.19 |
| Homoptera (Leaf/plant hoppers) | 0.01 | 0.012 | 0.09 | 0.06 | 0.06 | 0.12 |
| Coleoptera (Small grey weevil) | 12.30 | 12.31 | 16.29 | 19.32 | 29.67 | 14.07 |
| (Big grey weevil) | 39.57 | 21.88 | 31.76 | 52.64 | 44.56 | 40.96 |
|  | — | — | 0.29 | 0.09 | 0.36 | 2.58 |
| Lepidoptera |  |  |  |  |  |  |
| (Larvae) | 8.51 | 5.71 | 3.14 | 5.17 | 1.42 | 5.09 |
| (Moths) | — | 0.16 | 0.14 | — | — | 1.03 |
| Diptera |  |  |  |  |  |  |
| (Mosquitoes) | 0.04 | 0.03 | — | 0.01 | 0.02 | — |
| (Flies) | 0.02 | 0.003 | — | 0.007 | 0.01 | 0.04 |
| (Maggots) | — | 0.02 | 0.056 | 0.05 | 0.10 | — |
| Hymenoptera (Parasites) | 0.28 | 0.66 | 0.28 | 0.03 | 0.12 | 0.41 |
| (Bees and wasps) | 2.30 | 2.66 | 1.51 | 1.68 | 5.02 | 1.38 |
| (Myrmicinae) | 3.93 | 1.94 | 0.99 | 0.75 | 0.58 | 1.19 |
| (Formicinae) | 11.73 | 29.79 | 18.95 | 8.66 | 9.15 | 19.91 |
| Dictyoptera (Cockroaches) | — | 0.99 | 1.14 | 1.26 | 0.29 | — |
| Arachnida (Spiders) | 0.70 | 0.51 | 0.14 | 0.14 | 0.59 | 1.75 |
| Chilopoda (Centipede) | — | 0.41 | — | 0.52 | — | — |
| Annelida (Earthworm) | — | 0.36 | — | — | — | — |
| Mollusca (Gastropod molluscans) | — | 0.16 | 0.06 | — | — | — |

Coleoptera (although occurring in much less number and frequency than ants and termites), in terms of biomass, was the predominant insect order (Tables 3 & 4). A similar observation was made by Berry and Bullock (1962) in *B. melanostictus*.

The maximum biomass (mg) consumed per toad of Coleoptera was during the pre-hibernation period in *B. stomaticus*. The chitinous material of Coleoptera consumed during this period probably served as a long lasting source of energy and hence were preferred. Furthermore, Coleoptera may be present in more abundance than the other insect orders in the habitat of this toad. The consumption of large numbers Coleoptera by *Rana tigerina* has been shown by Khan (1973) during the pre-breeding period.

*Bufo stomaticus* was also observed to feed substantially on mosquitoes and dystiscid beetles during the rainy season in July- August 1985 (Table 1), when the toads were seen breeding in water. Mosquitoes and dystiscid beetles are abundantly in the water of flooded paddy fields (Kadan and Patel 1960). As is clear from the present study, *B. stomaticus* fed both on terrestrial and aquatic fauna. However, Berry and Bullock (1962) found *B. melanostictus* feeding exclusively on terrestrial insects.

In the present study, bees and wasps were also recorded from the guts in tangible amounts. Noble (1924) showed that ants and wasps were rejected by frogs and toads whereas, Tyler (1958) and Khera (1975) recorded their occurrence as prey items. Tyler (1958) reported that the available insect prey was de-

Table 4

TOTAL BIOMASS CONSUMED (MG) PER TOAD

| | | | | | | |
|---|---|---|---|---|---|---|
| Thysanura (Bristle tail larvae) | — | — | 0.11 | — | — | — |
| Diplura | — | 0.16 | — | — | — | — |
| Collembola (Spring tail) | 0.006 | — | — | — | — | — |
| Orthoptera (Grasshoppers) | 4.48 | 4.75 | 7.89 | 12.1 | 5.76 | 7.56 |
| (Crickets) | — | 0.89 | 0.49 | 3.03 | 6.48 | 2.84 |
| Isoptera (Termites) | — | 61.28 | 92.12 | — | — | — |
| Dermaptera (Earwigs) | 14.36 | — | 15.49 | 15.07 | 9.23 | — |
| Mallophaga (Chewing lice) | — | 0.004 | 0.004 | — | — | — |
| Thysanoptera (Thrips) | — | 0.004 | — | — | — | — |
| Heteroptera (Bugs) | 52.80 | 19.06 | 7.04 | 19.44 | 21.6 | 12.15 |
| Homoptera (Leaf/plant hoppers) | 0.04 | 0.05 | 0.46 | 0.32 | 0.32 | 0.24 |
| Coleoptera (Small grey weevil) | 42.82 | 47.33 | 81.73 | 99.73 | 158.67 | 27.63 |
| (Big grey weevil) | 137.07 | 84.12 | 158.54 | 271.70 | 238.33 | 80.44 |
| | — | — | 1.47 | 0.45 | 1.93 | 5.06 |
| Lepidoptera (Larvae) | 29.63 | 21.96 | 15.65 | 26.67 | 7.62 | 10.00 |
| (Moths) | — | 0.63 | 0.70 | — | — | 2.01 |
| Diptera (Flies) | 0.07 | 0.012 | — | 0.04 | 0.01 | 0.07 |
| (Mosquitoes) | 0.14 | 0.10 | — | 0.03 | 0.11 | — |
| (Maggots) | — | 0.08 | 2.81 | 0.25 | 0.54 | — |
| Hymenoptera (Parasites) | 0.96 | 2.55 | 1.39 | 0.13 | 0.62 | 0.81 |
| (Bees and wasps) | 8.04 | 10.21 | 7.55 | 8.68 | 26.87 | 2.71 |
| (Myrmicinae) | 13.68 | 7.45 | 4.93 | 3.89 | 3.09 | 2.33 |
| (Formicinae) | 40.84 | 114.53 | 94.58 | 44.70 | 48.96 | 39.11 |
| Dictyoptera (Cockroaches) | — | 3.84 | 5.67 | 6.52 | 1.55 | — |
| Arachnida (Spiders) | 2.44 | 1.94 | 0.72 | 0.73 | 3.14 | 3.44 |
| Chilopoda (Centipede) | — | 1.57 | — | 2.67 | — | — |
| Annelida (Earthworm) | — | 1.37 | — | — | — | — |
| Mullusca (Gastropod molluscans) | — | 0.62 | 0.29 | — | — | — |

pendent upon the type of vegetation in a particular habitat. According to Jensen and Klimstra (1966), Hedeen (1970) and Nigam (1979) anurans are opportunistic feeders and consume the most readily available food. The more frequent occurrence of toads in plant nurseries and orchards may be attributed to the easy availability of prey. Also, there seems to be a correlation between the abundance of toads and the ground fauna. However, Sweetman (1944) and Brower and Brower (1962) showed that anurans were capable of developing food preferences.

The seasonal variations in the diet of *B. stomaticus* in the present studies may be due to a change in the availability of fauna in a particular season and is in agreement with the observations of Tyler (1958), Brooks (1959, 1964), Turner (1959), Berry (1965), Khan (1973) and Khera (1975).

The present study reaffirms that toads are useful as control agents for various insect pests especially those belonging to the orders Coleoptera, Isoptera, Hymenoptera, Dermaptera and Diptera. Though toads appear to be opportunistic feeders, their feeding on many phytophagous insect pests does support their usefulness as biocontrol agents. A number of earlier workers like Gadow (1901). Pack (1922), Kadan and Patel (1960), Stiles *et al.* (1969) and Fellow (1969) also stressed the useful activity of toads.

The presence of stones, leaves and debris among the gut contents of *B. stomaticus* shows that the above material might have been engulfed accidentally along with the prey (Table 1). Vegetable matter occurred in many guts, but the amount was quite small and may thus be well explained as inadvertantly ingested with food. The intake of pebbles and plant matter may be important in providing roughage as well as increased girinding capacity for the total mass envelope. The presence of stones and vegetable matter in the guts of anurans has also been reported by earlier workers. Tyler (1958), Berry and Bullock (1962), Berry (1965), Joshee (1968) and Kramek (1972).

*Bufo stomaticus* was observed to capture insects of all sizes ranging from 1 to 25 mm in length and weighing from 0.12 to 200 mg. Tyler (1958) mentioned that the essential factor to be observed when considering the diet of an anuran species is the recognition that there is a limit to the size of the food items that can be ingested, varying according to the size of the individual frog and the jaw span. The studies of Brooks (1959, 1964) and Kramek (1972) also showed that the food of *R. catesbeiana* and *R. septentrionalis* varied with the body size, sex, change of locality and season.

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# MAHSEER CONSERVATION — PROBLEMS AND PROSPECTS[1]

PRAKASH NAUTIYAL[2]

## INTRODUCTION

Mahseer, well known as an anglers' delight, has numerous adjectives to its credit; colourful, fascinating, elegant, noble, aristrocratic and prized being some of them. Besides its status as an outstanding Game-Fish, it also finds mention in the Vedas and Smriti, the two epics of Hindu mythology. The Vedas consider it as a privileged fish used by Brahmins to propitiate the souls of their deceased ancestors. A fish so well known for the delicacy and pleasure provided during sport, is now in trouble .

No single cause can account for the current situation, which is an impact of several factors functioning together magnified at one or other stage of its life-history. This paper describes such factors which have been termed as 'Constraints'

**Natural Constraints:** In the case of the Garhwal Himalayan Mahseer (*Tor putitora*), the phenomenon of migration provides the necessary link between nature's food supply and reproduction and is thus of adaptive signficance. The fish lays its spawn where the young will have ample food, comparatively less danger of being predated upon and overall congenial environment for the eggs and young to survive. A tri-phased migration has been observed in *T. putitora* attributed mainly to maintenance of food supply in nature (Nautiyal and Lal 1984).

The first phase of the migration commences during March - April when the semi adults (which have not yet attained the size- at-first-maturity) alongwith a few broodfish ascend from their feeding grounds in the foothill stretches into the snow-fed tributaries of the Ganga namely the Alaknanda and the Bhagirathi. This is in response to general rise in water temperature of the Ganga from 16°C during December to 20°C during March - April, attributed to melting of snow. The tributaries being comparatively cool during spring (14 - 16° C) provide congenial surroundings for overwintering. As the ice cover continues to recede, a gradual increase in the turbidity is registered which may be considered as a stimulus for their gonads to mature.

The second phase is marked by movement of the brood fish during July to the spawning grounds. The third phase involves descending migration of the pre-recruits alongwith the juveniles and the immature adults (which had ascended with the commencement of the first phase) from their feeding grounds firstly into the 'snow-fed' hillstreams and then into the Ganga. The water temperature starts decreasing during July and the streams get flooded and turbid. Both turbidity and temperature act as stimulus for brooders. The temperature of the spawning grounds ranged from 21°- 25°C.

Mahseer exhibits great diversity in food and feeding habits. They have been reported to be 'Herbivorous' (Desai 1970), 'Herbi- omnivorous' (Das and Pathani 1978), 'Carni-omnivorous' (Badola and Singh 1980), 'Insectivorous' (Khanna and Pant 1964) and 'Carnivorous' (Nautiyal and Lal 1984 a). They may feed extensively on one type of food (monophagic) throughout their life-history or may feed on variety of food (steno - and euryphagic) and exhibit transition from animal to plant matter or vice versa. Interestingly enough the fingerlings of Kumaun Mahseer are zoophagus in nature (Pathani and Joshi 1979) as compared to their adults which switch over to more of a herbivorous diet (Das and Pathani 1978). Contrary to its euryphagic nature the Garhwal Himalayan Mahseer is monophagic, feeding exclusively on insect diet as compared to their fingerlings and fry which subsist on plant matter only. The versatile nature is in response to food available at different times in same as well as different environs. According to a review on Mahseer Fishes of India (Sen and Jayaram 1982) *T. tor* juveniles feed on insects and the adults switch over to herbivcrous diet.

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A glance at its feeding ecology reveals that the water temperature and current considerably influence the food habits and supply (Nautiyal and Lal 1985). A temperature range of 12° —27 °C prevailing in the spring-fed streams, supporting the juvenile stages, alongwith low to moderate current (0.2426 - 1.4529 m/sec) except monsoon, accounts for flourishing entomofauna. These two factors also exert significant influence on the feeding intensity. The intensity was observed to be maximum when water temperature and current were recorded to be low, 12° - 14°C and 0.2426 - 0.2874 m/sec, respectively. These two alongwith high turbidity act in a complex and thus become inmical to feeding intensity which thereby registers a considerable decline. The fry and fingerlings inspite of high turbidity feed voraciously. Although, water current and temperature regulate the food-supply to a certain extent, turbidity plays a pivotal role in maintaining the supply. The turbidity also governs the feeding intensity and is hence a limiting factor. These factors govern the food habits to a certain extent only.

The quality of food in essential quantity as compared to quantity only has a greater impact on the reproductive activity by significantly influencing the growth rate. Consequently the scarcity of quality food may retard the rate of growth to the extent that it may effect a delay in the attainment of sexual maturity, for in fishes, the latter is associated to size rather than age of the fish (Monastryskii 1940). Putitor Mahseer, being a rheophilic species (in Garhwal Himalaya), attains a large size and faces food problems. In foothill stretches the 'basic food' gets scarce, not because of its density decreasing, but owing to the size of the fish and the volume of food consumed by it which naturally falls short of the required diet. This assumption is supported by the observation that the feeding intensity declines in later stages of life as compared to young stages which feed voraciously (Nautiyal and Lal 1984 a). The impact on the growth rate becomes quite evident from Table 1. During first year the fish attains a length of 162. 58 mm. As the fish grows in size the rate records a decreasing trend from 110.74 to 108.71 mm in second and third years respectively. The feeding intensity was observed to decline after the fish attained a length of 220 mm and age of 1+ (Table 2). the decrease in growth rate is obviously due to decline in the feeding intensity during the second year when the fish is of about 235.5 mm in length.

The Mahseer populations in the various lakes too have suffered a set back due to ever increasing pollution load. The latter naturally hampers both, the feeding and breeding activities. The phenomenon of successful breeding as already mentioned, most essential for the survival, is affected by food habits of the fish and like feeding habits differs in different environs. It spawns once in a year in Garhwal waters (Nautiyal 1984), twice in Himachal (Sehgal *et al.* 1971), thrice in Punjab (Khan 1939) and even throughout the year intermittently in certain reservoirs (Bhatnagar 1964).

Attainment of maturity is the threshold to reproductive capacity and since it is directly associated to attainment of a particular size,

TABLE 1

GROWTH RATES AS EVIDENCED BY BACK—CALCULATED LENGTHS AND EXPECTED WEIGHTS

| | 1+ | 2+ | 3+ | 4+ |
|---|---|---|---|---|
| Average | | | | |
| Observed length (mm) | 175.50 | 235.50 | 355.50 | 535.50 |
| Back—calculated length (mm) | 162.58 | 273.09 | 381.80 | 515.65 |
| Annual Increase | | | | |
| Length (mm) | 81.21 | 110.74 | 108.71 | 133.85 |
| Weight (gms) | 234.15 | 321.10 | 315.21 | 359.70 |

Table 2

VARIATIONS IN THE PERCENTAGE FREQUENCY IN THE CONDITION OF FEED FOR DIFFERENT SIZE-GROUPS

| Size-groups | State of Intestinal Bulbs (%) | | | | | | Age-groups |
|---|---|---|---|---|---|---|---|
| | Empty | Poor | 1/4 | 1/2 | 3/4 | Full | |
| 41—100 | 5.38 | 2.15 | 8.60 | 20.43 | 37.63 | 25.81 | 0+ |
| 101—160 | 5.48 | 8.22 | 16.44 | 31.51 | 17.81 | 20.55 | 0+ |
| 161—220 | 2.94 | 17.65 | 20.59 | 55.88 | 20.59 | 11.77 | 0+, 1+ |
| 221—280 | — | 50.0 | — | 30.00 | 20.00 | — | 1+, 2+ |
| 281—340 | 33.33 | 16.66 | 33.33 | 16.66 | — | — | 1+, 2+ |
| 341—400 | — | 66.66 | 33.33 | — | — | — | 2+, 3+ |
| 401—460 | — | 50.00 | 25.00 | 25.00 | — | — | 2+, 3+ |

the growth rate of the species matters much which in turn is governed by the nourishment available. The Kumaun Mahseer has been observed to mature at a size less than half to that of the Garhwal Himalayan Mahseer (Nautiyal 1984). Apparently the size and nature of the water body influences the biota which in turn governs the growth rate and eventually the size-at-first maturity. Various species of Mahseer attain maturity at different lengths in different environs, the Narmada Mahseer at 360 mm (Desai 1973), the Garhwal Himalyan Mahseer at 700 mm (Nautiyal 1984), but none mature at a size smaller than the common carp or other commercially important food fish.

The fecundity of Mahseer as compared to the commercially exploited species, is very low. While the fecundity of the Garhwal Himalyan Mahseer of 780 mm is 26,977, the Narmada, the Deccan and the Kumaun Mahseer have 30,420, 20,000 and 7076 ova for specimens measuring 625 mm, 620 mm and 390 mm respectively (Desai 1973, Kulkarni and Ogale 1978, Pathani 1981). The Narmada Mahseer has 6000 eggs/kg body weight as compared to 2,61,000 eggs/kg body weight of the rohu and 1,33,000 eggs/kg body weight for catla. Evidently the Mahseer have a low reproductive capacity which with the delayed maturity may have impact as far as their survival is concerned.

After spawning the problem of fertilization and survival of the larvae, arises. The Deccan Mahseer has been reported to have a long hatching period of 80 hours and a 6-day semi-quiescent stage which proves to be very disastrous (Kulkarni and Ogale 1978).

**Created Constraints:** The constraints arising out of the activities of man can be broadly classified into (a) Indirect constraints and (b) Direct constraints. The former category is represented mainly by various hydroelectric projects whereby barriers in the form of weirs and dams are erected across the river, thus blocking the migration passage for ever, besides isolating the population and effecting a change in the riverine ecology which in turn disturbs the food supply as well as the breeding prospects. The fish is essentially a migrant, especially for spawning in warm shallow waters of spring-fed streams and any sort of barrier across the migratory passage will hamper the breeding prospects thus enhancing the possibilities of endangering the species. Use of explosives etc to exploit the fish population leads to mass mortality, resulting in indiscriminate overfishing, thus accounting for the created constraints. The same is being practised in the Indian uplands with great enthusiasm as they have no fear of being punished. Preventive rules, whatsoever, are non-existent in these parts of the country and use of explosives, chemicals etc. goes unchecked. The fishing stress on the population commences from the very moment fish attains an attractive size and that too, quite before it matures sexually. The stress is heavy on the brood fish.

To sum up, unsuccessful breeding is a biological and thus a 'Natural Constraint' which is further magnified by 'created constraints' mentioned above. This has resulted in endangering the Mahseer.

**Attempts to rehabilitate the Mahseer:** In 1976 the National Commission of Agriculture in its report on *Fisheries* had recommended extensive survey and detailed ecological and biological investigations to save Mahseer from the adverse effects of indiscriminate fishing and river valley projects. As a reaction a few isolated attempts were made to breed the Mahseer, but with limited success (Tripathi 1978, Pathani and Das 1979). So far the only rehabilitation measures on sizable scale have been undertaken by the Tata Electric Companies, Lonavala (Maharashtra) in their Lakes (Kulkarni & Ogale 1978) and by the Wild Life Association of South India and Karnataka Fisheries Department.

The plans to rehabilitate Mahseer can be chalked out only after the factors responsible for the decline are clearly distinguished. Sen and Jayaram (1982) have attributed stock depletion to;

1. Use of explosives. 2. Wanton Killing of brood fish in the spawning season. 3. Ecological changes in the riverine systems of the country and 4. continued constructions of dams and reservoirs on rivers and streams destroying their migratory routes.

These factors can be categorically included under 'Created Constraints', but none except Kulkarni and Ogale (1978) have mentioned 'Natural Constraints'. Similarly the author besides the factors mentioned above, has laid stress on *delayed maturity* in the Garhwal Himalayan Mahseer.

**Conservation Measures:** Having identified the handicaps, proper measures to rehabilitate the species have to be undertaken. Taking the case of the Garhwal Himalayan Mahseer the first hurdle to be overcome is the delay in the attainment of sexual maturity. If the fish matures at an earlier stage the vulnerability to human assault will be reduced consequently enhancing the chances of successful reproduction.

From the studies conducted on the Kumaun Mahseer (Pathani 1981a & b) it is obvious that sexual maturity in Putitor Mahseer is attained at an early stage in lentic environs i.e. at 300 mm as compared to 700 mm in case of Garhwal Himalayan Mahseer existing in lotic environment. The difference in growth is likely to be due to the lotic and lentic environment. Hence if the fish has to be conserved it has to be propagated in the lentic environment and these water bodies have to be kept safe and human encroachment avoided. Regular monitoring of water quality is also essential.

The Garhwal Himalaya is full of such water bodies which are still virgin and can serve the purpose of conservation. These alongwith the proposed new reservoirs of various hydroelectric and irrigation projects can be conveniently utilized for this purpose.Most important aspect thereafter is the job of the fish culture experts to breed the fish. The fish seed has then to be transferred to various lentic and lotic sites deemed fit for stocking them. I speculate that this target can be achieved within 5 years. Such water bodies at a later stage may be thrown open to enthusiastic anglers. Promoting recreational fishing should be one of the means to achieve success in conservation (Nautiyal and Nautiyal 1982). It will also enable the fish to retain its status of prized Game-Fish.

That a closed season must be promulgated with immediate effect and other conservation measures which can aid in checking the man made problems have been discussed earlier by numerous authors including the present author (Nautiyal and Lal 1982, Nautiyal and Nautiyal 1982 and Nautiyal 1984a). The need for Fish Sanctuaries is obvious.

The cause of Mahseer has to be fostered urgently. It is under active consideration that Mahseer should be declared as an endangered species but declaration of good intention do not solve the problem. Will conservationists help the Mahseer?

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# ADDITIONS TO THE FLORA OF PUNJAB STATE, NORTH INDIA[1]

S.S. BIR AND CHARANPREET SINGH[2]

Extensive surveys in Gurdaspur district of Punjab state have indicated that 69 species falling under 56 genera are new records. These plants are mostly from hilly ranges falling in Pathankot tehsil. Quite a number of plants are met with in Narot Jaimal Singh area across river Ravi bordering Pakistan.

## INTRODUCTION

During the years 1983-1986 we undertook botanical excursions throughout the disrict of Gurdaspur, Punjab state, North India under the Botanical Survey of India's 'District Flora Scheme'. Quite a good portion of the area of the district is sub- mountainous tract falling in Pathankot tehsil and is a part of the Shivalik range, the hills attaining a maximum height of 960 m (Katori) near Punjab-Himachal Pradesh border. A large part of the proposed Thein Dam reservoir falls in the hilly tract of Gurdaspur district and comes under the administrative Dhar Kalan block. A large number of hill plants found in the area, therefore constitute part of Punjab Flora and those reported new to the state have not earlier been recorded from the state in the taxonomic works that deal with either the whole or part of the area under study (Steward 1869, Bamber 1916, Parker 1918, Sabnis 1940-41, Stewart 1945, Nair & Nair 1963-66, Rau 1968, Singh 1971 and Nair 1978). It is interesting to note that some plants which occur in the Shivalik hills in the district are also met with in the plains area of the district particularly near Narot Jaimal Singh bordering Pakistan. The River Ravi demarcating India's International boundary flows mostly on the North-Western side of the district except for Narot Jaimal Singh which is across the river Ravi and is easily accessible from Kathua in J K state. Such hill species which are met within the plains area of the district are marked with an asterisk. Seeds or propagules of such species are easily carried down to the plains by streams and rivulets and these establish well under a suitable environment. Our scrutiny of the literature and comparison at Botanical Survey of India, Dehradun Herbarium (BSD) have indicated that 69 species belonging to 56 genera falling in 28 families have not been reported previously from Punjab state and are enumerated here. The voucher specimens have been deposited in the herbarium of Punjabi University (PUN) and duplicates are at Herbarium of the Botanical Survey of India, Dehradun (BSD). The arrangement of families is the same as in 'Flora British India' by Hooker (1872-97).

## ENUMERATION OF NEWLY RECORDED TAXA

### RANUNCULACEAE

1. *__Clematis gouriana__ Roxb. Climber, on all types of trees and shrubs in hill tract.
   Fl. & Fr. August-December.
   *C.P. Singh* 9728, Thein Dam, 2 October, 1983.

### BRASSICACEAE

2. **Lepidium perfoliatum** Linn. Common on higher slopes in shade.
   Fl. & Fr. January-March.
   *C.P. Singh* 13209, Katori, 10 March, 1986.

### POLYGALACEAE

3. **Polygala abyssinica** R.Br. On open hilly-slopes.
   Fl. & Fr. September-March.
   *C.P. Singh* 13216, Katori, 10 March, 1986.

### HYPERICACEAE

4. **Hypericum cernuum** Roxb. Along slopes.
   Fl. & Fr. March-May. *C.P. Singh* 13623, Katori, 10 March, 1986.

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GERANIACEAE

5. ***Geranium lucidum** Linn. On roadsides and hill slopes.
Fl. & Fr. March-May.
*C.P. Singh* 13126, Thein Dam, 9 March, 1986.

6. ***G. ocellatum** Camb. Cool and shady places.
Fl. & Fr. February-April.
*C.P. Singh* 13172, Dunera, 10 March, 1986.

7. **G. wallichianum** Don ex Sweet. On slopes.
Fl. & Fr. October-April.
*C.P. Singh* 13197, Katori, 10 March, 1986.

FABACEAE

8. **Argyrolobium flaccidum** Jaub. & Spach. In Valleys.
Fl. & Fr. May-July.
*C.P. Singh* 13630, Katori, 16 May, 1985.

9. **Atylosia crassa** Prain. Climbing on many trees and shrubs particularly *Carissa opaca* stapf.
Fl. & Fr. December-April.
*C.P. Singh* 13184, Dunera, 10 March, 1986.

ROSACEAE

10. **Crotalaria pusilla** Heyne, Common along slopes.
Fl. & Fr. October-March.
*C.P. Singh* 13212. Katori, 10 March, 1986.

11. **Desmodium podocarpum** DC. Common along roadsides.
Fl. & Fr. July-September.
*C.P. Singh* 13624, Katori, 16 October, 1985.

12. **Pyrus pashia** Buch.-Ham. ex D. Don. Small, shade tree along hilly-slopes.
Fl. & Fr. March- October.
*C.P. Singh* 9722, Dunera, 1 October, 1983.

13. **Rosa brunonii** Lindl. Forest undergrowth.
Fl. & Fr. April- May.
*C.P. Singh* 13111, Dunera, 10 March, 1985.

14. **Rubus biflorus** Buch.-Ham. Roadside shrub.
Fl. & Fr. April-May.
*C.P. Singh* 13637, Katori, 18 May, 1985.

15. **R. ellipticus** Sm. Straggler Shrub, along roadsides.
Fl. & Fr. February-May.
*C.P. Singh* 13202, Katori, 10 March, 1986.

APIACEAE

16. **Bupleurum hamiltonii** Balak. Common on grassy slopes of hills.
Fl. & Fr. October-December.
*C.P. Singh* 13207, Katori, 10 March, 1986.

17. ***Scandix pecten-veneris** Linn. Along roadsides and field edges.
Fl. & Fr. January-April.
*C.P. Singh* 13151, Narot Jaimal Singh, 10 March, 1986.

18. ***Torilis japonica** (Houtt) DC. Along field edges and roadsides.
Fl. & Fr. February-April.
*C.P. Singh* 13152, Narot Jaimal Singh, 10 March 1986.

CAPRIFOLIACEAE

19. ***Viburnum coriaceum** Bl. Hill sides.
Fl. & Fr. July-September.
*C.P. Singh* 10968, Thein Dam, 24 June, 1985.

20. ***V. erubescens** Wall. Small tree along hill slopes.
Fl. & Fr. April-October.
*C.P. Singh* 13263, Pathankot, 14 March, 1986.

RUBIACEAE

21. ***Galium asperifolium** Wall. Common along slopes.
Fl. & Fr. June-August.
*C.P. Singh* 9453, Kahanpur. 6 August, 1983.

22. **G. histiflorum** Req. Common along hillsides.
Fl. & Fr. July-August.
*C.P. Singh* 13638, Katori, 15 August, 1985.

23. **Plectronia neilgherrensis** Bedd. var. chartacea Gamble. Small tree along rivers.
Fl. & Fr. February-April.
*C.P. Singh* 13204, Katori, 10 March, 1986.

ASTERACEAE

24. **Achillea millefolium** Linn. Along terraced fields.
Fl. & Fr. May-August.
*C.P. Singh 13113,* Dunera, 10 August, 1985.

25. **Anaphalis busua** (Buch.-Ham.) Hand.-Mazz. Along slopes.
Fl. & Fr. July-October.
*C.P. Singh* 13183, Dunera, 10 August, 1985.

26. **A. contorta** Hook. f. Common along slopes.
Fl. & Fr. July-September.
*C.P. Singh* 13114, Dunera, 10 August 1985.

27. **Carpesium trachefolium** Less. As forest undergrowth.
Fl. & Fr. July-September.
*C.P. Singh* 13628, Katori, 15 August, 1985.

28. **Erigeron multicaulis** DC. Along the slopes.
Fl. & Fr. May-October.
*C.P. Singh* 13622, Katori, 16 October, 1985.

29. **Myractis wallichii** Less. Common along slopes.
Fl. & Fr. June-September.
*C.P. Singh* 13627, Katori, 16 October, 1985.

30. ***Silybum marianum** (Linn.) Gaertn. Common along roadsides in Pathankot tehsil. Fl. & Fr. February-May. *C.P. Singh* 13192, Shahpur Kandi, 9 March, 1986.

31. ***Taraxacum officinale** Webber. Along roadsides and moist places.
Fl. & Fr. December-April.
*C.P. Singh* 13162, Narot Jaimal Singh, 10 March, 1986.

LOBELIACEAE

32. ***Lobelia heyniana** Roem. & Schult. Common in shady, grassy places.
Fl. & Fr. September-December.
*C.P. Singh* 9454, Sujanpur, 6 August, 1986.

PRIMULACEAE

33. **Androsace umbellata** (Lour.) Merr. Common in damp and exposed places.
Fl. & Fr. February-April.
*C.P. Singh* 13156, Bhattwan, 10 March, 1986.

SYMPLOCACEAE

34. ***Symplocos sumuntia** Buch.-Ham. ex D. Don. Large shrub, along roadsides.
Fl. & Fr. September-November.
*C.P. Singh* 9717, Dunera. 1 October, 1983.

OLEACEAE

35. ***Jasminum humile** Linn. Along hedges, wild.
Fl. & Fr. August-October, March-April.
*C.P. Singh* 13169, Narot Jaimal Singh, 10 March, 1986.

36. ***J. multiflorum** (Burm. f.) Andr. Along roadside hedges, wild.
Fl. & Fr. October-March.
*C.P. Singh* 13168, Narot Jaimal Singh, 10 March, 1986.

GENTIANACEAE

37. **Centaurium centaurioides** (Roxb.) comb. nov. Along the canals and water channels.
Fl. & Fr. March-June.
*C.P.Singh* 13282, Madhopur, 13 March, 1986.

38. **Gentiana argentea** (Royle ex D. Don) DC. Along hill slopes. Fl. & Fr. February-March.
*C.P. Singh* 13187, Katori, 10 March, 1986.

39. **Swertia purpurescens** Wall. Common along hilly slopes. Fl. & Fr. August-September.
*C.P. Singh* 13639, Katori, 16 September, 1985.

CONVOLVULACEAE

40. **Ipomoea muricata** (Linn.) Jacq. Climbing on trees and shrubs in hedges.
Fl. & Fr. September-November.
*C.P. Singh* 13625, Katori, 15 October, 1985.

41. **Ipomoea sindica** Stapf. In cultivated fields.
Fl. & Fr. August-October.
*C.P. Singh* 12225, Madhopur, 19 October, 1985.

SCROPHULARIACEAE

42. **Limnophila connata** (Buch.-Ham. ex Don) Hand.-Mazz. In moist places.
Fl. & Fr. September-October, February-April.
*C.P. Singh* 13243, Madhopur, 13 March, 1986.

43. **Limnophila indica** (Linn.) Druce. In moist places.
Fl. & Fr. October-April.
*C.P. Singh* 13244, Madhopur, 13 March, 1986.

44. **Sutera dissecta** (Del.) Walp. In moist places.
Fl. & Fr. February-April.
*C.P. Singh* 13241, Madhopur, 13 March, 1986.

ACANTHACEAE

45. **Barleria buxifolia** Linn. Along hedges.
Fl. & Fr. July-April.
*C.P. Singh* 13185, Katori, 10 March, 1986.
46. ***Rostellularia diffusa** Nees. In moist places.
Fl. & Fr. September-February.
*C.P. Singh* 9740, Murgala (Dinanagar), 3 October, 1983.
47. ***R. mollissima** Nees. In waste and shady places.
Fl. & Fr. September-February.
*C.P. Singh* 9719, Dunera, 10 October, 1983.

LAMIACEAE

48. **Ajuga parviflora** Benth. Roadside herb of hilly areas.
Fl. & Fr. March-May.
*C.P. Singh* 13215, Katori, 10 March, 1986.
49. **Nepeta graciliflora** Benth. Along roadsides in hilly areas. Fl. & Fr. September-November, March-April.
*C.P. Singh* 13201, Katori, 10 March, 1986.
50. **Plectranthus japonicus** (Burm.f.) Koidz. Along hill-slopes. Fl. & Fr. October-March.
*C.P. Singh* 13208, Katori, 10 March, 1986.

PLANTAGINACEAE

51. **Plantago lanceolata** Linn. Along roadsides in grassy localities.
Fl. & Fr. March-May.
*C.P. Singh* 13203, Katori, 10 March, 1986.

POLYGONACEAE

52. **Polygonum alatum** Buch.-Ham. In damp places.
Fl. & Fr. January-November.
*C.P. Singh* 13620, Katori, 12 January, 1985.
53. **P. amplexicaule** Don. In moist places.
Fl. & Fr. June-October,
*C.P. Singh* 13116, Katori, 13 August, 1985.
54. **P. capitatum** Buch.-Ham. Along roadside rocks and walls in hilly tract.
Fl. & Fr. June-November.
*C.P. Singh* 13117, Katori, 13 August, 1985.
55. **P. donii** Meissn. In moist places.
Fl. & Fr. July-October.
*C.P. Singh* 9460, Cantonment (Pathankot), 7 October, 1983.

LORANTHACEAE

56. **Loranthus pulverulentus** Wall. Semiparasite on *Dalbergia sissoo* Roxb. and other trees in hill-tract.
Fl. & Fr. September-November; March-April.
*C.P. Singh* 9714, Dunera, 1 October, 1983.
57. **Scurrula cordifolius** (Wall.) G. Don. On many trees.
Fl. & Fr. September-October; March-April.
*C.P. Singh* 13182, Dunera, 10 March, 1986.

EUPHORBIACEAE

58. **Flueggea virosa** Roxb. ex Willd. Small tree of slopes.
Fl. & Fr. March-October.
*C.P. Singh* 13120, Dunera, 10 March, 1986.

ULMACEAE

59. ***Trema orientalis** Roxb. Small tree, along roadsides.
Fl. & Fr. July-October.
*C.P. Singh* 9416, Chakki Bridge (Pathankot),
5 August, 1983.

LILIACEAE

60. **Asparagus adscendens** Roxb. Straggler of hilly roadsides.
Fl. & Fr. October-March.
*C.P. Singh* 13189, Niari, 10 March, 1986.
61. **Nothoscordum inodorum** (Ait.) Nicholson. Newly introduced herb into India. As orchard undergrowth.
Fl. & Fr. January-March.
*C.P. Singh* 10948, Batala, 7 January, 1985.
62. **Tulipa stellata** Hook.f. Roadsides and fields in hill-tracts. Fl. & Fr. March-April.
*C.P. Singh* 13161, Bhamlada, 10 March, 1986.

### JUNCACEAE

63. **Juncus concinnus** Don. Along higher slopes.
Fl. & Fr. July-September.
*C.P. Singh* 13631, Katori, 15 August, 1985.

### CYPERACEAE

64. **Cyperus cyperoides** (Linn.) O. Kuntze. Along forest and field edges.
Fl. & Fr. July-November.
*C.P. Singh* 9422, Chakki bridge (Pathankot),
5 August, 1983.

### POACEAE

65. **Chrysopogon fuluus** (Spreng.) Choiv. Common on gravelly and rocky slopes in hill-tract.
Fl. & Fr. July-September.
*C.P. Singh* 13632, Katori, 16 August, 1985.

66. **Eragrostis curvala** Nees. Common in waste places.
Fl. & Fr. January-April.
*C.P. Singh* 13249, Dera Baba Nanak, 6 March, 1986.

67. **Pennisetum flaccidum** Griseb. Along hill-slopes.
Fl. & Fr. September-November.
*C.P. Singh* 13635, Katori, 15 August, 1985.

68. ***Themeda villosa** (Poir) d. Camus. In river beds and field edges.
Fl. & Fr. August-November.
*C.P. Singh* 13633, Katori, 16 October, 1985.

69. **Tripogon filiformis** Nees. Common along hill-siopes.
Fl. & Fr. September-November.
*C.P. Singh* 12220, Thein Dam, 10 September, 1985.

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# BREEDING HABITS AND ASSOCIATED PHENOMENA IN SOME INDIAN BATS-PART XII - *MEGADERMA LYRA LYRA* (GEOFFROY) (MEGADERMATIDAE) AT DIFFERENT LATITUDES[1]

A. Gopalakrishna[2] and N. Badwaik[3]

The breeding habits of *Megaderma lyra lyra* have been studied from four localities in India, namely, Srirangapattana, Aurangabad, Bhandara and Agra. This species breeds once a year and has an autumn pattern of breeding. In spite of the varying latitudes the time of conception and the time of delivery are nearly same in all the localities except that the onset of breeding is advanced by a few days at lower latitudes.

## INTRODUCTION

There are very few reports on the breeding habits of the same species of bats at different latitudes. The work of Dwyer (1963, 1966, 1968) and Richardson (1977) on two species of *Miniopterus* at different southern latitudes and of Ramakrishna and Rao (1977) on *Rhinolophus rouxi* at different northern latitudes demonstrated that latitude and ecological conditions play a significant role in influencing the breeding biology of these bats although the basic breeding behaviour is genetically controlled. In *Miniopterus* in Australia the duration of delayed implantation of the blastocyst becomes progessively protracted towards higher (southern) latitudes. The Indian *Rhinolophus rouxi,* although having a basic 'autumn' pattern of breeding, exhibits a delay of blastocyst implantation and retarded early embryonic development at higher (northern) latitudes. Ramakrishna and Rao (1977) contended that the variations in the breeding habits of *Rhinolophus rouxi* at different latitudes are adaptations to bring forth the young ones at the most propitious period when insects are available in abundance. Apart from the work on *Rhinolophus rouxi* there is no report on the reproduction of any Indian species of bats at different parts of India, although India, which extends from almost near the equator to the deep sub-tropical region and has wide variations in climatic conditions, offers ideal conditions for studying the influence of latitude and ecological factors on the reproductive habits of at least those species, which have a wide distribution and occur throughout the subcontinent. One such species is *Megaderma lyra lyra*. This paper presents observations on this species from four localities, namely, Srirangapattana (12° N, 76° 43' E), Aurangabad (19° 55' N, 73° 23' E), Bhandara (21° 9' N, 79° 42' E) and Agra (27° 10' N, 78° 5' E). Ramakrishna (1949, 1951) and Ramaswamy (1961) studied the reproductive habits of this species in south India and at and near Agra respectively. Bats from these places or localities close to these places have also been included in the present study with a view to filling up the lacunae in earlier studies and to present a comprehensive picture of the breeding behaviour of this bat from widely differnt localities with varying climatic and ecological conditions.

## MATERIAL AND METHODS

Specimens of *Megaderma lyra lyra* were collected from dungeons in the old fort at Srirangapattana, from an underground tunnel below Bibi-ka Mukbara at Aurangbad, from old cow sheds and grain godowns at and around Bhandara and from the dungeons in the fort and from dilapidated old monuments at and near Agra for two successive years from each locality so that every calendar month is represented by one collection or more. Table 1 gives monthwise details of the collections of specimens from the different localities. The specimens were killed by chloroform or by decapitation and their genitalia dissected out and

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fixed in various ways after noting down the details of the external characters of the reproductive organs in the male and mammary glands and pubic dugs in the females. The tissues were transferred to 70% ethanol after fixation for 24 hours. The right testis was weighed in all the males after separating it from the epididymis. The tissues were processed by the usual procedure and paraffin embedded tissues were serially sectioned at 5 to 8 micron thickness. For the present report a few sections from each series were stained with Harris' or Ehrlich's haematoxylin, counterstained with eosin and mounted in DPX or Canada Balsam after dehydrating by passing through graded ethanol and clearing in xylol.

## OBSERVATIONS AND DISCUSSIONS

**General notes on the breeding habits:** In all the localities studied here the two sexes come to sexual activity synchronously once a year. All adult specimens in the colony copulate in a sharply defined season and all adult females conceive immediately after copulation. As a rule only the left ovary releases a single ovum during each cycle and the foetus is carried in the left uterine cornu. The right side of the genitalia is functional in very rare cases (only four specimens among all examined from all localities) and only a single case of twinning was noticed. The young one is carried by the mother constantly for 20 to 25 days, but lactation and suckling continues for 15 to 20 days more. The testes and the accessory glands in the males undergo regression within a short time after copulation.

**Breeding habits in different localities:** In all the localities breeding season for *Megaderma lyra lyra* commences late in autumn or early in winter. It must, however, be mentioned that the terms 'autumn' and 'winter' do not connote the same meanings in Indian circumstances as they do in temperate regions. These terms are employed here to denote the season approximating the months which fall under these seasons in temperate regions of northern hemisphere. All adult females in the colony undergo copulation within a period of 8 to 10 days and likewise all deliveries in the colony occur within 8 to 10 days after a gestation of 145 ± 5

TABLE 1

MONTHWISE COLLECTION DATA OF *Megaderma lyra lyra* FROM DIFFERENT LOCALITIES

| Month | Srirangapattana (1981 - 1983) | | | | Aurangabad (1963 - 1965) | | | | Bhandara (1972 - 1974) | | | | Agra (1982 - 1984) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Males | | Females | | Males | | Females | | Males | | Females | | Males | | Females | |
| | I | A | I | A | I | A | I | A | I | A | I | A | I | A | I | A |
| January | 2 | 9 | 3 | 13 | 4 | 13 | 4 | 15 | 6 | 26 | 6 | 23 | 3 | 15 | 8 | 27 |
| February | 3 | 8 | 4 | 13 | 4 | 14 | 8 | 20 | 12 | 34 | 10 | 41 | 5 | 18 | 15 | 30 |
| March | - | 2 | 6 | 14 | 3 | 11 | 6 | 22 | 3 | 15 | 7 | 27 | 2 | 12 | 6 | 18 |
| April | (2) | 5 | 2(3) | 12 | 5(6) | 14 | 6(7) | 34 | 4(3) | 19 | 2(4) | 26 | 3(5) | 33 | 8(6) | 34 |
| May | (2) | 2 | 3(3) | 9 | (6) | 6 | 2(5) | 17 | 1(1) | 9 | 1(2) | 15 | 1(4) | 33 | 6(4) | 18 |
| June | 6(6) | 2 | 7(4) | 17 | 3 | 6 | 5 | 13 | 7 | 16 | 6 | 20 | 3 | 20 | 6 | 14 |
| July | 7 | 4 | 6 | 8 | 1 | 5 | 2 | 6 | 4 | 11 | 2 | 11 | 2 | 6 | 1 | 5 |
| August | 5 | 2 | 2 | 5 | 2 | 7 | 1 | 5 | - | 5 | 3 | 7 | 3 | 13 | 9 | 21 |
| September | 5 | 14 | 7 | 15 | 4 | 12 | 5 | 16 | 7 | 15 | 6 | 18 | 5 | 20 | 7 | 20 |
| October | 2 | 7 | 3 | 8 | 5 | 21 | 6 | 23 | 11 | 29 | 15 | 32 | 3 | 24 | 8 | 33 |
| November | 3 | 5 | 4 | 9 | 3 | 15 | 6 | 17 | 6 | 19 | 6 | 28 | 4 | 17 | 8 | 27 |
| December | 2 | 11 | 5 | 17 | 12 | 41 | 11 | 65 | 7 | 21 | 12 | 35 | 4 | 22 | 9 | 28 |
| Total | 35(10) | 71 | 52(10) | 140 | 46(12) | 165 | 62(12) | 253 | 68(4) | 219 | 76(6) | 283 | 38(9) | 233 | 91(10) | 275 |

Figures in brackets represent sucklings.

I = Immature, A = Adult

days. Table 2 gives the earliest date on which a pregnant female was captured and the earliest date on which a newly delivered young one was noticed in the different localities where the study was carried out. A study of the table brings out two facts. First, the earliest conceptions occur in November and the earliest deliveries in April in all the localities. However, the date of conception and the date of delivery are postponed by a few days progressively from the lower to the higher latitudes. Regardless of the above change the gestation period is nearly the same in all the localities.

The breeding behaviour of the males has been reported breifly elsewhere (Gopalakrishna and Sapkal - in press). The commencement and the peak stage of spermatogenetic activity and the activity of the accessory glands are postponed by a few days progessively from the lower to the higher latitudes synchronizing with the onset of heat and ovulation in the female in the respective locality.

The four locations from which the specimens have been studied vary considerably in regard to external factors such as annual and diurnal variations in the ambient temperature, the duration of day light during different seasons and the season and the amount of rainfall. Yet the breeding season of *Megaderma lyra lyra* is basically same in all the localities with only a slight preogressive change from the lower to higher latitudes. Evidently, the sexual periodicity of this species is essentially determined by its own internal rhythm, which is genetically controlled, and the influence of external factors, if any, is only marginal. The factor of food in influencing sexual periodicity in this species can be ruled out since this is common in all the localities; this species is basically insectivorous supplemented by carnivorous diet as this species some times feed on lizards and frogs.

A survey of literature on the breeding behaviour of bats reveals that autumn breeding is the normal pattern in most species both in the temperate and tropical regions. Only a few species breed during other seasons. Perhaps, the latter cases are adaptations to meet some special environmental demands. Species such as *Rousettus leschenaulti* (Gopalakrishna and Choudhari 1977) and *Cynopterus sphinx* (Ramakrishna 1947, Sandhu and Gopalakrishna 1984, Sandhu 1984) combine both autumn and spring breeding patterns since they breed twice a year in quick succession.

An interesting outcome of these studies is the variations in the sex ratio at different stages of life. Table 3 gives these details. From the table it is evident that whereas the sex ratio is nearly even in the sucklings, it becomes progressively female dominant as age advances. The ratio is approximately 40% males and 60% females after weaning. Evidently, there appears to be a preferential mortality of the males during this critical period resulting in female dominant sex ratio in the adult stage. A similar female dominant sex ratio occurs in other bats (Gopalakrishna and Madhavan 1970) except in

TABLE 2

EARLIEST DATES ON WHICH CONCEPTION AND PARTURITION WERE NOTICED IN DIFFERENT LOCALITIES

| Locality | Earliest date of conception | Earliest date of parturition | Gestation period in days |
|---|---|---|---|
| Srirangapattana | 14th November<br>(free egg) | 13th April | 150 |
| Aurangabad | 18th November<br>(2 cell stage) | 15th April | 148 |
| Bhandara | 24th November<br>(4 cell stage) | 17th April | 148 |
| Agra | 26th November<br>(4 cell stage) | 20th April | 149 |

*Taphozous melanopogon* (Abdulali 1949, Sapkal and Khamre 1984). It must, however, be mentioned that this species has been shown to migrate during certain seasons of the year and often only the females migrate to investigation of several colonies during all the months of the year will yield correct data regarding the actual sex ratio of this species also. The precise reason for the preferential mortality of the males during a particular phase of the life of *Megaderma lyra lyra* is not known. This appears to be the case in other bats too.

## ACKNOWLEDGEMENT

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TABLE 3

LOCALITYWISE DISTRIBUTION OF THE SPECIMENS

| Locality | Sucklings | | Free young | | Adult | | Total | |
|---|---|---|---|---|---|---|---|---|
| | Male | Female | Male | Female | Male | Female | Male | Female |
| Srirangapattana | 10 | 10 | 35 | 52 | 71 | 140 | 116 | 202 |
| Aurangabad | 12 | 12 | 46 | 62 | 165 | 253 | 223 | 327 |
| Bhandara | 4 | 6 | 68 | 76 | 219 | 283 | 291 | 365 |
| Agra | 9 | 10 | 38 | 91 | 233 | 275 | 280 | 376 |
| Total | 35 | 38 | 187 | 281 | 688 | 951 | 910 | 1270 |
| Percentage (Approximate) | 48 | 52 | 40 | 60 | 42 | 58 | 42 | 58 |

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# THE SNAKES OF BURMA
# II. REDISCOVERY OF THE TYPE SPECIMEN OF *OLIGODON MCDOUGALLI* WITH A DISCUSSION OF ITS RELATIONSHIPS[1]

H.G. Dowling and J.V. Jenner[2]

(*With two text-figures*)

The unique type specimen of *Oligodon mcdougalli* Wall, 1905, long believed to have been lost (Smith 1943), was found in the reptile collection of the Bombay Natural History Society. An amplified description of the type is presented. Its features suggest that it is closely related to a species group which includes *O. catenata* and *O. dorsalis*.

The Arakan Kukri snake *Oligodon mcdougalli* was described early in this century by Wall (1905). Later, however, Smith (1943: 234) reported that, "the type and only known specimen cannot now be found." It was to our surprise, therefore, that we found *"Oligodon mcdougalli"* listed in the catalogue of the reptile collection of the Bombay Natural History Society (BNHS 963), and the corresponding specimen in a labeled jar. Thus, although the specimen was not marked as a type, it apparently was "lost" only to Smith.

In spite of some slight inconsistencies in data, there appears to be no reason to doubt that this specimen is the type. It was collected by E. McDougall at "Sandarang" (later corrected to Sandoway [Rakhine State, 18° 28' N, 94° 22' E], Burma. The date given in the catalogue (31 December 1907) is believed to be the accession date, rather than the date of collection. In as much as Wall gave only a brief description of the unique type, and because the specimen does not appear to have been examined since its description, we give here an amplified description.

We can confirm Wall's tentative identification of the specimen as a male. It is stiff and somewhat faded, but reasonably well-preserved for its age. We measure it at 337 mm total length, with the tail 45 mm. Wall's measurements were 13 3/4 and 1 7/8 inches, a little longer than ours, but this is explicable as shrinkage over the years. As he indicated, the body is cylindrical, with little distinction between the head and the body. The tail is abruptly pointed.

His description of the colour pattern is precise and more complete than can now be ascertained:

> "Colour dusky-black laterally, with a rufous brown vertebral stripe from nape to tip of tail involving the vertebral and half the adjacent row; this stripe is edged by a series of linear black spots, most evident anteriorly. A linear black line on the confines of the 2nd and 3rd rows above the ventrals, interrupted anteriorly, and ending at vent. A supra-anal black bar and another subterminal, caudal, black bar. Head blackish. Rostral rufous-yellow. Blotched black below. Labials mottled black and rufous-yelow. A rufous collar incomplete vertebrally. Chin, and throat rufous-yellow, mottled black in the sutures. Belly black, mottled fawn. [Darker posteriorly.] Beneath tail black laterally, crimson centrally, the colour of a ripe yew-berry, and reminding one of the tail of *Simotes cruentatus*."

The "dusky-black" has faded to dark brown and the yellows and reds are now a dirty cream colour, but otherwise the description matches the specimen precisely.

We count 199 ventrals and 40 subcaudals (vs. Wall's 200 and 39). Otherwise the counts match exactly. The head scutes are as shown in his drawings (redrawn here as Fig. 1): the internasals are separated from the prefrontals, the

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[1] Accepted January 1987. This is the second in a series of papers on the "Snakes of Burma". The first is a checklist of the species, published in Smithsonian Herpetological Information Service, No.76, 1988.

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nasal is single, the loreal is absent, oculars are 1 + 1, and the temporals, 1 + 2. There are 7-7 supralabials, with the third and fourth entering the orbit, and 7-7 infralabials. There are two pairs of genials, the posterior pair about 2/3 the size of the anterior and in contact throughout their length. The dorsal scales are smooth and without apical pits. They are arranged in 13 + 13 + 13 rows.

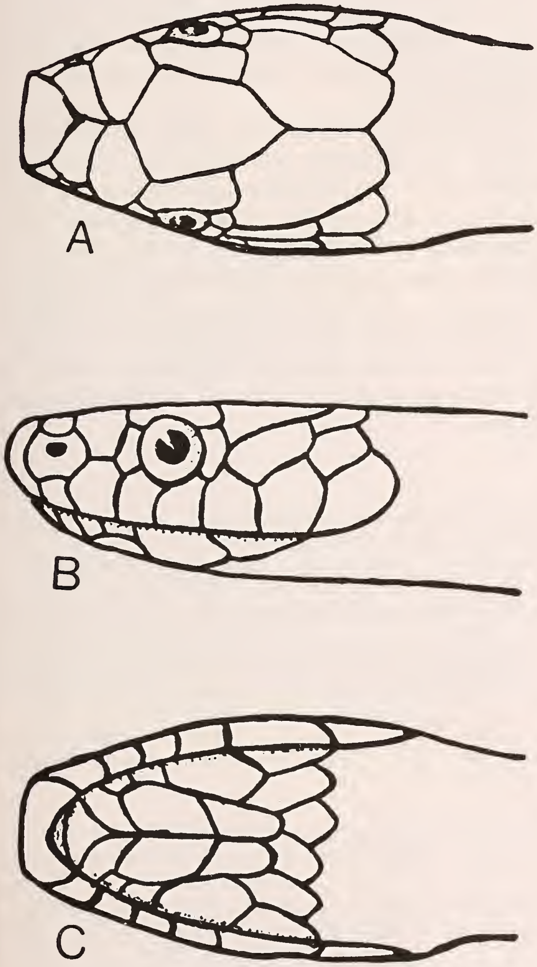

Fig. 1. Head scutellation of *Oligodon mcdougalli*. Redrawn from Wall (1905). The drawings were compared with the type specimen (BNHS 1963) and found correct.

The maxillary is edentulous anteriorly. There are six maxillary teeth, the last three much enlarged and blade-like, but without a diastema separating them from the anterior series. [Thus, the dental formula is 0 + 6.]

Paired hemipenes are present, but are very fragile and difficult to observe. The organs appear to extend to subcaudal (SC) 15 as entire (undivided) structures, but any distal ornamentation, if present, cannot be determined. Spinose calyculae (joined into flounces?) can be seen to SC 7 and spinules appear to extend to SC 10. Little beyond that can be determined without complete destruction of the hemipenis. [The right organ was left intact.]

## RELATIONSHIPS

The genus *Oligodon* ranges from the Tanimbar islands east of Timor through the East Indies and the Philippines to the Malayan Peninsula, and then northward to southern China and westward, south of the Himalayas, to Pakistan. It is made up of more than 60 currently recognized species (and more than double this number that have been placed in synonymy). All are small snakes (less than a meter in length) with an enlarged rostral scute and three or four enlarged teeth at the rear of the maxilla. All have the same basic head patterns and are similar in major structural features. The bewildering number of species has been described on the bases of minor differences in scutellation and various patterns of coloration. Probably not half of the currently recognized species are valid.

Nevertheless, until the degree of variation within populations is determined and until features of dentition, osteology, and soft anatomy are better described, little can be done to identify the valid species and species groups within this genus. Unquestionably, some of the current species names are based upon interpopulational variations in scutellation or pattern. Ultimately it will take population analyses from geographic, structural, and biochemical standpoints to resolve the systematic problems. Unfortunately, knowledge of the hemipenial structure of these snakes, which Wall (1923) suggested might have some potential in resolving some of the taxonomic problems, has progressed very little in the last 45 years.

The 12 species reported from Burma appear to fall into two distinct groups on the basis of dentition (Table 1). One group has a maxilla that is edentulous anteriorly, and bears only six to eight teeth. The other group lacks the edentulous anterior end and has nine or more teeth.

It is clear that *Oligodon mcdougalli* belongs with the first group and that it differs from the other members in relatively minor ways. The fusion of internasals or loreal with the prefrontals is a commonly-observed feature in snakes (especially burrowing snakes) that possess a short maxilla (*A*. Downs, 1967), and probably has been over-emphasized as a species character in *Oligodon*. It is especially notable that all of the members of the first group are allopatric except *O. hamptoni*, which lies between *O. dorsalis* and *O. catenata*, both geographically and morphologically (Fig. 2). It seems possible that the five named forms are actually no more than members of a single variable species.

No other species of *Oligodon* appears to have been recorded from this region of southwestern Burma, however, and none of the species described by Taylor (1965) from Thailand is similar. *O. mcdougalli* resembles the southern Burmese species *O. planiceps* (Boulenger, 1888) in dorsal scale formula, but differs widely in maxillary tooth count as well as in the numbers of labials, ventrals, and subcaudals. It differs also in colour pattern.

It agrees with the northern Burmese species *O. catenata* (Blyth, 1854) in most respects, including the colour pattern, dorsal scale row count, and ventral and subcaudal counts. It differs mainly in the presence of separate internasals, an additional supralabial, and one less maxillary tooth.

A species based upon a single specimen is always questionable and there are as yet no studies that would offer information on the amount of intraspecific variation that might be anticipated in the head scutes of *Oligodon*. Until it can be shown that the presence or absence of separate internasal scutes is an individual variation, therefore, it appears best to recognize *O. mcdougalli* as a valid species related to the more northern *O. catenata* and its adjacent forms.

TABLE 1

MORPHOLOGICAL FEATURES OF SPECIES OF *Oligodon* FROM BURMA AND ADJACENT REGIONS. SPECIES ARE ARRANGED BY MAXILLARY TOOTH COUNT

| MX | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0+6 | 13+13+13 | 199. | 2 | 40 | 2 | 1 | 0 | 1 | 1 | 7 | *O. mcdougalli* | B |
| 0+6-7 | 15+15+13 | 162-188 | 2 | 27-51 | 2 | 1 | 1 | 1-2 | 1 | 7 | *O.dorsalis* | H,B,E |
| 0+7 | 15 | 160-175 | 2 | 30-32 | 0 | 1 | 0-1 | 1 | 1 | 5 | *O. hamptoni* | B |
| 0+7 | 13+13+13 | 186-208 | 2 | 37-40 | 0 | 1 | 0 | 1 | 1 | 6 | *O. catenata* | B |
| 0+7-8 | 15+15+13 | 154 | 2 | 46 | 2 | 1 | 0 | 2 | 1 | 7 | *erythrorhachis* | H |
| 9-10 | 17+17+15<br>to<br>21+21+17 | 165-195 | 1 | 37-58 | 2 | 2 | 1 | 2 | 1-2 | 7-8 | *O. cyclurus* | H-IC |
| 10 | 13+13+13 | 132-142 | 2 | 22-27 | 2 | 1 | 0 | 2 | 1 | 4-5 | *O. planiceps* | B |
| 10-11 | 21+21+17 | 169-193 | 1 | 35-47 | 4 | 2 | 1 | 2 | 2 | 8 | *O. splendidus* | B |
| 10-12 | 15 | 162-178 | 2 | 25-33+ | 0 | 1 | 0 | 2 | 1 | 5 | *O.lacroixi* | IC |
| 10-12 | 15+15+13?<br>to<br>17+17+15 | 157-185 | 1 | 29-42 | 2 | 2 | 1 | 2 | 1 | 8 | *O. cinereus* | B-IC |
| 10-12 | 19+19+15 | 162-208 | 1 | 53-68 | 2 | 2 | 1 | 2 | 1 | 7 | *O. juglandifer* | H |
| 10-12 | 19+19+15<br>to<br>21+21+15 | 177-208 | 1 | 47-69 | 2 | 2 | 1 | 2 | 1 | 7 | *O. albocinctus* | H |
| 14-16 | 17+17+15 | 148-173 | 2 | 27-40 | 2 | 2 | 0-1 | 2 | 1 | 8 | *O. cruentatus* | B |
| 15-16 | 15+15+13 | 144-159 | 2 | 26-34 | 2 | 1 | 1 | 2 | 1 | 7 | *O. torquatus* | B |
| 15-16 | 17+17+15 | 164-180 | 2 | 30-42 | 2 | 2 | 1 | 2 | 1 | 8 | *O. theobaldi* | H-B |

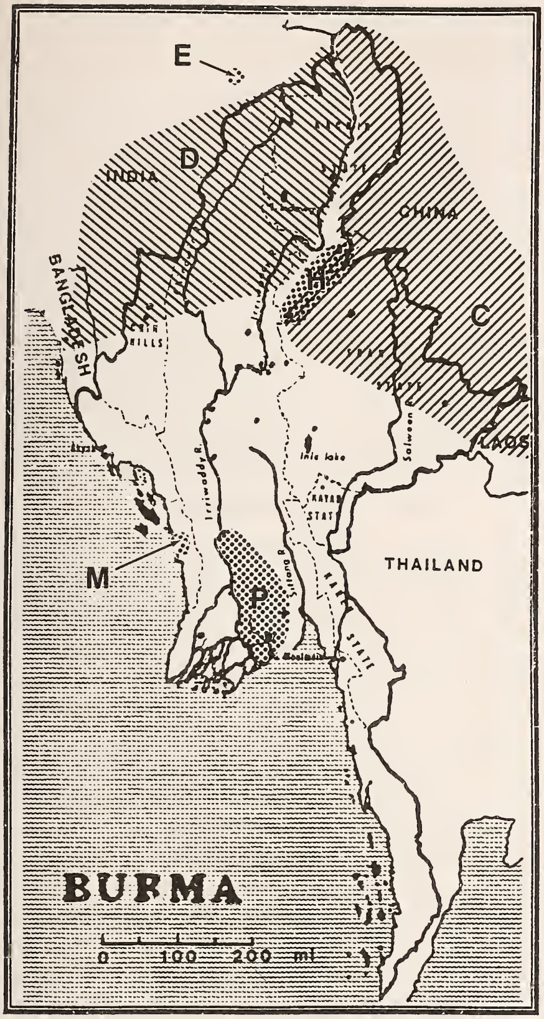

Fig. 2. Map of Burma, indicating: (M) the type locality of *Oligodon mcdougalli*, and the approximate known ranges of geographically adjacent and possibly related species, (C) *O. catenata*, (D) *O. dorsalis*, (E) *O. erythrorhachis*, (H) *O. hamptoni*, (P) *O. planiceps*.

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# BIOECOLOGICAL STUDIES ON THREE FIG-LITTER DWELLING SPECIES OF RHYPAROCHROMINAE (INSECTA: HEMIPTERA: LYGAEIDAE)[1]

ANANDA MUKHOPADHYAY[2]

*(With six text-figures)*

Some biological and ecological aspects like occurrence, feeding and reproductive behaviour, post-embryonic development with nymphal descriptions of three fig-litter dwelling rhyparochromine bugs, *Rhyparothesus bengalensis* (Distant), *Rhyparothesus sparsus* (Distant), and *Metochus uniguttatus* (Thunberg) are presented in this paper.

## INTRODUCTION

Members of rhyparochrominae, the largest lygaeid subfamily, are in majority cryptic litter-dwellers and have therefore, attracted little attention of the naturalists. However, some recent contributions on the ecology and biology of these bugs from different parts of the globe are that of, Sweet (1964), Slater (1972 & 1975), Eyles (1963, 1964 & 1973), Malipatil (1975 & 1979), May (1965), Thomas (1955), Thompson and Simond (1964) and Putshkova (1956).

Bioecological information on Oriental rhyparochromines are scanty and fragmentary excepting some reports by Thangavelu (1978a) from southern India. Amongst the three fig-litter dwelling species studied here, *Rhyparothesus bengalensis* (Distant) and *Rhyparothesus sparsus* (Distant) are known only from Indian subregion, as compared to a wider distribution of *Metochus uniguttatus* (Thunberg) throughout the Orient. Maxwell-Lefroy (1909) reported *Rh. bengalensis* to abound in fallen leaves and debris at the base of the trunks of big trees like *Pipal* (Hindi) (Peepul, *Ficus religiosa*) associated with other rhyparochromines like *Elasmolomus sordidus* (Fabr.) and *Rh. orientalis* (Dist). Further he reported *M. uniguttatus* to frequent in fallen leaves and grass in India. However, Chatterjee (1937) reported the species from healthy sandal (*Santalum alba*). Except for the original description of *Rh. sparsus* and its report from India by Distant (1904) nothing is known about the binomics of the bug. So an attempt is made here to present some ecological and biological information of three of these commonly occurring rhyparochromine species of fig-litters in eastern India. The study is meant for better understanding of the life-style of these little known cryptic bugs and their beneficial role in nature.

## MATERIAL AND METHODS

(i) **Field collection:** All the three species of rhyparochromines were collected by using aspirator with interchangable vials and some times using the inlet tubes of different diameters depending on the size of the bug. Slight disturbance created in the litter- habitat triggered escaping movement of the cryptically coloured bugs and thereby helping in their location. For fast running large species, like *M. uniguttatus*, hand picking gave better result.

(ii) **Laboratory rearing:** Of the two culture methods, 'dirty' and 'clean' often recommended for lygaeids, the latter was preferable for studying the biology of the three rhyparochromine species in question. Small jars (10.5 cm x 9 cm) were chosen for studying the oviposition and fecundity of separate pairs of bugs while for mass rearing and studying some behavioural aspects larger jars (22 cm x 13 cm) were used. The mouths of the jars were covered with cloth. Nymphs were reared in separate vials (10 cm x 3 cm) for recording the nymphal stadia (by detecting exuvae). All the jars and vials were supplied inside with water siphons. The eggs studied for incubation period and hatching success were kept in separate small vials plugged with moistened cotton to provide adequate humidity.

## OBSERVATIONS AND RESULTS

**Habitats and food habits:** The three species

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of rhyparochromines were often found to share the same litter habitat of huge peepul trees (*Ficus religiosa* L.), but in different proportions. *Rh. sparsus* also occurred in litters of other figs, like *F. benghalensis* L. (Banyan) and *F. infectoria* Roxb. (*pakur*). Although adult and nymphs of *M. uniguttatus* were observed in litters of *F. religiosa* and *F. benghalensis*, their nymphs were also found associated with litter of *F. hispida* Linn. f. The long-legged adults and 5th instar nymphs of this bug were good runners, and therefore, often escaped from litter-habitat to surrounding meadows and vegetations and could be collected under grass or small weeds. In some places of southern West Bengal and in particular Sagar Island this bug was found to infest unripe pods of gingelly (*Sesamum indicum* DC.). *M. uniguttatus* was also recorded from the litter of *Artocarpus chapalasha* Roxb. (Moraceae) and *Lagerstroemia speciosa* Pers (Lythraceae) from northeastern states of India. From the same region *Rh. sparsus* is recorded from litter of *Duabanga sonneratioides* Ham. (Lythraceae).

From spring to autumn the peepul and banyan trees kept irregularly fruiting, thereby, keeping the bug-population flourishing in the litter of different fig trees. Nevertheless in the litter of non-fruiting trees at times some adults and late instar nymphs occurred. On rare occasions even in winter, if a peepul or banyan tree bore fruits or had enough dry seeds in the litter, adults and nymphs of all the three species with a number of other lygaeid bugs appeared. In general the colder part of winter (10° - 12°C) was tied over by all the three species in adult form.

The fig fruits and seeds present in the litter were the main source of food. The fruits dropped with ripening but their shedding was much enhanced by the feeding activity of a number of vertebrate commensals, such as bats, birds, and squirrels (Appendix 1). Seed remnants present in the droppings (faeces) of these agents were also appropriated by the bugs.

Seed defence habit was common to all the three species. Seeds were normally carried at the tip of rostrum to safe and secured places for feeding. Cannibalism was observed in adults and in late instars of *Rh. sparsus* but such a behaviour was uncommon for *Rh. bengalensis* and *M. uniguttatus*. *Rhyparothesus sparsus* adults were found feeding on 5th instar, and the latter again on the 4th instar of its own. Cannibalism took place even in presence of good supply of food and water but the propensity increased with the dearth of food and water. Advance nymphs of *M. uniguttatus* when handled without care occasionally inflicted mild bites.

**Courtship and mating behaviour:** The sexual behaviour was found almost similar for all the three species of rhyparochromine. The males of *Rh. sparsus* and *Rh. bengalensis* approached a receptive female with up and down movement of the antennae, whereas, the males of *M. uniguttatus* generally approached with their antennae straight and horizontal. When close to a receptive female, which kept steady, the male patted the female by stroking the antennae on its back. On final agreement the male mounted the motionless female often holding her by last two pairs of legs. The courting pair was found at times to be in a still state with the male partially mounted on the female for long periods. To a receptive female the male repeatedly leaned to one side to secure the attachment. After attachment, the male descended and turned in the opposite direction, so that the individuals of a copula faced away from one another. If a female refused to copulate, the male tickled the female first by two legs and antennal ends and then turned over her back for investigation.

All the three species repeatedly mated in the same season. In *Rhyparothesus* spp. a single mating lasted normally from half to one hour, whereas for *M. uniguttatus* it continued for about a couple of hours in undisturbed condition. The individuals of a copula of *Rh. sparsus* were often found to move their antennae and to continue feeding during the act. Gravid females of all the three species normally avoided male company and rejected any attempt of further mating. When kept in constant company of male, the freshly emerged virgins of *Rh. sparsus* started mating within a period of about six days and *Rh. bengalensis* within three days. Virgin *M. uniguttatus* laid a few unfertile eggs without any male company.

**Oviposition and fecundity:** *Rhyparothesus sparsus* laid eggs scattered, feebly attached to litter substrate and in small furrows made in loose soil. In nature, *Rh. bengalensis* could not be observed laying but their laying habits in laboratory indicated their similarities with those of *Rh. sparsus*. In laboratory both the species preferred to attach their eggs to rough, pilose surfaces of cotton cloth, cotton wool and rough surfaces of fig fruits. Peculiar repetitive up and down movements of ovipositor (valves) and its scooping of loose soil particles were observed in the bugs. Eggs were normally laid scattered singly or in small groups of two or three. The apparent sticky nature of the eggs was due to minute warts on the chorion and a fluid on the egg surface. Eggs of *M. uniguttatus* were also difficult to locate in natural habitat. In laboratory eggs were singly attached to the covering cloth of the rearing jar, on rough surface of the fig fruits and at times on smooth glass surface, feebly glued, despite the presence of rough surfaces.

Both the species of *Rhyparothesus* laid on an average larger number of eggs than *M. uniguttatus*. However, for *Rh. sparsus* mean eggs laid per female and the average eggs laid per day per female was about double those of *Rh. bengalensis* (Table 1), nonetheless on considering daily laying rhythms the latter at times exceeded the former (Fig. 1).

**Incubation:** Although incubation periods were overlapping for all the three rhyparochromine species, yet eggs of *M. uniguttatus* hatched more successfully than those of other two *Rhyparothesus* species (Fig. 2). Successful hatching was estimated based on the total eggs collected for 12 consecutive days in early parts of laying periods (Table 2).

The eclosion phenomenon was essentially alike in all the three rhyparochromines. The pulsation caused by the embryo from within the egg resulted in a number of irregular cracks within the circlet of the micropylar processes. The cracks extended, making an opening for a wriggling nymph that emerged normally enveloped in an amniotic membrane. For a successful hatching the membrane either split-up while the nymph was half inside the chorion or when completely outside it, thereby freeing an active nymph. At times nymphs could not free themselves from the enveloping membrane and as a result perished . Hatching from a batch of egg was usually complete within three days but some eggs did not hatch at all. By the end of laying period a female often started laying fair number of empty, sunken and unfertilized eggs, this was more common for *Rh. sparsus* than the other two species.

TABLE 1

COMPARISON OF PREOVIPOSITION PERIOD, LONGEVITY AND FECUNDITY OF *Rh. sparsus, Rh. bengalensis* AND *M. Uniguttatus*

(BASED ON FIVE OBSERVATIONS)

| Preoviposition period (Days) | Longevity Female (Days) | Total eggs laid / Female | Average eggs/ Female /diem |
|---|---|---|---|
| | | *Rh. sparsus* | |
| Mean 9.8 | 27.0 | 23.0 | 11.31 |
| Range (9-11) | (21-33) | (105-547) | (5-16.58) |
| S.D. 0.83 | 5.09 | 174.19 | 4.45 |
| | | *Rh. bengalensis* | |
| Mean 4.6 | 38.8 | 221.8 | 5.91 |
| Range (4-5) | (26-52) | (177-262) | (4.15-7.42) |
| S.D. 0.54 | 9.33 | 38.8 | 1.33 |
| | | *M. uniguttatus* | |
| Mean 10.6 | 22.8 | 89.0 | 3.68 |
| Range (9-12) | (17-29) | (19-171) | (1.1-5.9) |
| S.D. 1.14 | 4.76 | 55.23 | 1.8 |

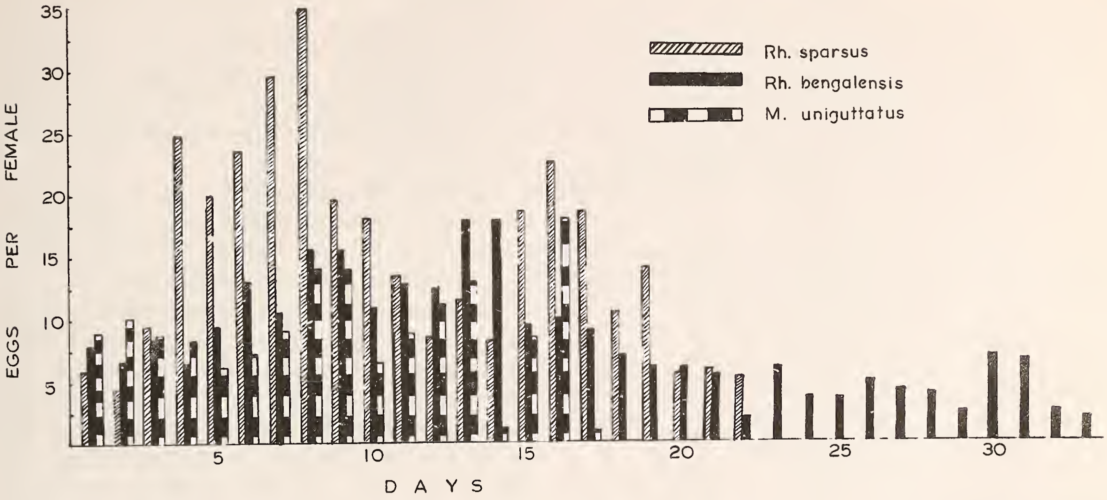
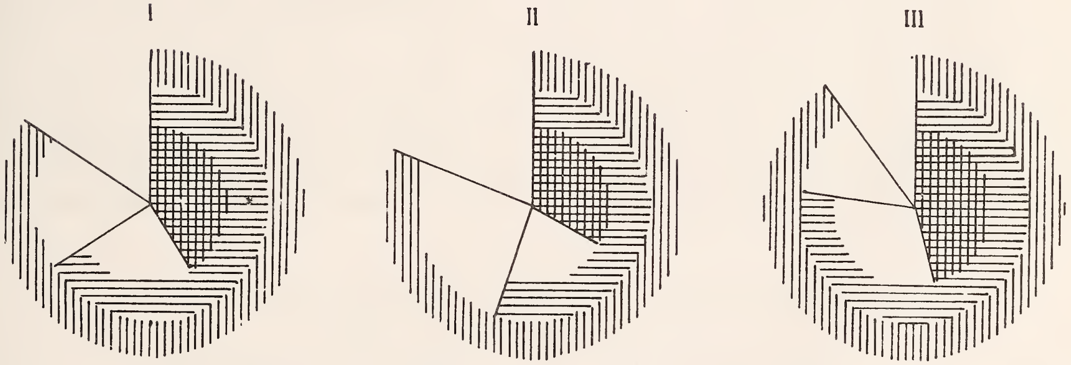


Fig. 1. Oviposition trends of three species of Rhyparochrominae.



| | HATCHING SUCCESS | MAX. ▥ | AVE. ▤ | MIN. ▦ |
|---|---|---|---|---|
| I | Rh. sparsus | 84.6% | 65.97% | 41.3% |
| II | Rh. bengalensis | 81.25% | 55.% | 32.61% |
| III | M.uniguttatus | 90% | 71.62% | 46.6% |

Fig. 2. Hatching success of three species of Rhyparochrominae.

**Post embryonic development:** Of the two species of *Rhyparothesus, Rh. bengalensis* interestingly took rather a longer period for its nymphal development than the other congener, *Rh. sparsus* (Table 3). The former, however showed an overlapping range of post-embryonic periods with *M. uniguttatus* (Fig. 3 A-E).

The maximum nymphal mortality of the rhyparochromines occurred in first and second instars, and when kept isolated, the mortality increased. Nymphs metamorphosed more successfully when reared in numbers in the same jar. Rough surfaces like fruit- rind, cotton-plug, piece of cloth were often preferred for casting the exuviae.

TABLE 2

COMPARISON OF INCUBATION PERIODS AND HATCHING SUCCESS OF *Rh. sparsus*, *Rh. bengalensis* AND *M. uniguttatus* EGGS

(BASED ON OBSERVATIONS OF TWELVE BATCHES OF EGGS)

| | Incubation period (Days) | Successful hatching (%) |
|---|---|---|
| | *Rh. sparsus* | |
| Mean | 4.33 | 65.97 |
| Range | (3-5) | (41.3-84.6) |
| S.D. | 0.577 | 12.87 |
| | *Rh. bengalensis* | |
| Mean | 6.25 | 55.0 |
| Range | (4-8) | (32.61-81.25) |
| S.D. | 0.753 | 11.73 |
| | *M. uniguttatus* | |
| Mean | 5.85 | 71.62 |
| Range | (5-6) | (46.6-90.0) |
| S.D. | 1.354 | 17.48 |

**The egg:** Eggs of *Rh. sparsus* and *Rh. bengalensis* are similar in general appearance. Freshly laid eggs are shiny, cylindrically ovoid, pale yellow (pearly), cephalic end slightly broader than the other. Maturing eggs turn reddish, showing red colour of the embryo's eyes. Under high magnification, chorion appears rough with rows of spiny warts and circlet of micropylar processes at the cephalic end (Fig. 4 A). *M. uniguttatus* eggs are more cylindrical with both the ends bluntly rounded. Freshly laid eggs were pale yellow but on maturity turned pink or reddish yellow. Deep red bands (impression of nymphal abdomen and eyes) were visible through the translucent chorion (Fig. 6 A).

Eggs of *M. uniguttatus* were greater in length and diameter than the eggs of other two *Rhyparothesus* spp. which showed overlapping ranges of measurements (Table 4).

**Description of the nymphal instars:** (Measurements in mm. are the means based on ten specimens). Nymphs of *Rh. bengalensis* closely resemble those of *Rh. sparsus* and are morphologically difficult to distinguish (specially the early instars) excepting when morphometrics are taken into account. So the following descriptions up to fourth instar in general hold good for both the species of *Rhyparothesus*.

**1st nymphal instar:** (Figs. 4B and 6B). *Rh. sparsus* and *Rh. bengalensis*: Head, pro-and meso-notum pale yellow; anterior abdomen and patch around dorsal abdominal scent-gland openings reddish yellow; eyes ruby red; pale yellow antennae with brown annular band at proximal region of pilosed 3rd and 4th segments; first segment with a fuscous thin proxi-

TABLE 3

COMPARISON OF STADIA AND POST EMBRYONIC DEVELOPMENT PERIOD OF *Rh. sparsus*, *Rh. bengalensis*, AND *M. uniguttatus*

(BASED ON TEN OBSERVATIONS)

| (Days) | 1st Instar | 2nd Instar | 3rd Instar | 4th Instar | 5th Instar | Total |
|---|---|---|---|---|---|---|
| | | | *Rh. sparsus* | | | |
| Mean | 4.5 | 4.4 | 3.3 | 3.0 | 5.4 | 20.6 |
| Range | (4-5) | (3-5) | (2-5) | (2-5) | (4-7) | (17-24) |
| S.D. | 0.527 | 0.699 | 0.823 | 1.247 | 0.966 | 2.17 |
| | | | *Rh. bengalensis* | | | |
| Mean | 7.9 | 8.0 | 3.9 | 4.2 | 7.8 | 31.8 |
| Range | (7-9) | (5-13) | (2-5) | (3-6) | (5-12) | (26-41) |
| S.D. | 0.875 | 2.538 | 0.994 | 1.135 | 2.616 | 4.442 |
| | | | *M. uniguttatus* | | | |
| Mean | 6.7 | 6.8 | 5.1 | 5.8 | 10.0 | 34.4 |
| Range | (6-8) | (6-8) | (4-6) | (5-7) | (8-13) | (30-38) |
| S.D. | 0.823 | 0.788 | 0.737 | 0.788 | 1.699 | 2.674 |

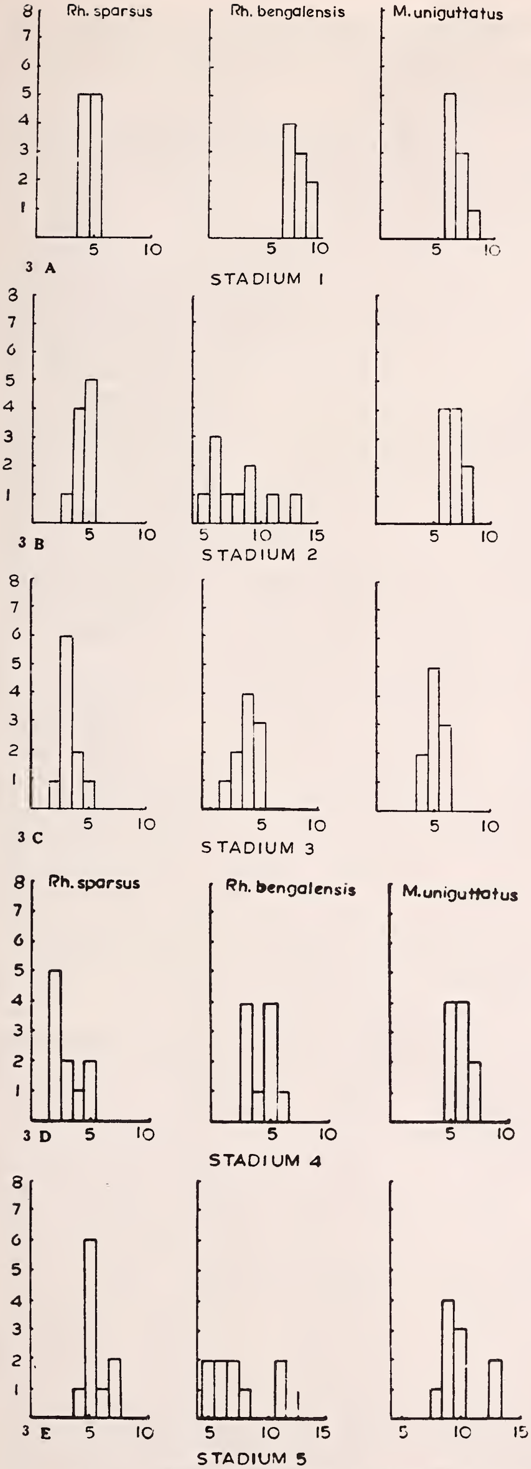


Fig. 3. (A-E). Frequency distribution of duration of 1st to 5th instars of three species of Rhyparochrominae. Abscissae, time in days; ordinates, number of observations.

TABLE 4

COMPARISON OF MICROPYLAR PROCESSES, LENGTH AND BREADTH OF *Rh. sparsus*, *Rh. bengalensis* AND *M. uniguttatus* EGGS (BASED ON TEN OBSERVATIONS)

| | Micropylar processes | Length (mm) | Breadth (mm) |
|---|---|---|---|
| | | *Rh. sparsus* | |
| Mean | 6.0 | 0.89 | 0.43 |
| Range | (5-7) | (0.85-0.9) | (0.4-0.45) |
| S.D. | 1.0 | 0.02 | 0.02 |
| | | *Rh. bengalensis* | |
| Mean | 5.6 | 0.92 | 0.41 |
| Range | (5-7) | (0.89-0.96) | (0.36-0.48) |
| S.D. | 0.894 | 0.112 | 0.192 |
| | | *M. uniguttatus* | |
| Mean | 5.4 | 1.31 | 0.56 |
| Range | (5-6) | (1.3-1.35) | (0.5-0.6) |
| S.D. | 0.547 | 0.02 | 0.04 |

mal band; labial segments pale except brownish 1st and 4th segments; legs luteous, hind femora blackish, fore femora with one small spine located ventrolaterally at distal inner end; pleural and other coxal area brownish.

*M. uniguttatus*: Head and thorax deep brown; metathoracic region reddish membranous with a pair of brown rectangular sclerotization at metanotal region; eyes deep red; 1st and 4th antennal segment partly and 3rd fully fuscous; excepting 3rd, tip of 4th and 1st, 2nd labial segments fuscous; abdomen bright red with pale yellow colour between the red band of anterior abdomen and black plate surrounding scent glands on tergal segments 3rd- 4th, 4th-5th and 5th-6th; anal segment black; legs luteous with tibia light ochraceous; labium reaches 5th abdominal segment; 3 preorbital and 2 postorbital setae on head; 1st, 2nd antennal segments pubescent; anal segment with a pair of ventrolateral bristles; labial end with some and each thorax with a pair of setae on each side; mid ventral abdomen with sparse decumbent hair.

| | *Rh.sparsus* | *Rh. bengalensis* | *M.uniguttatus* |
|---|---|---|---|
| Body length | 1.4 | 1.37 | 2.01 |
| Head width | 0.37 | 0.34 | 0.5 |
| Max. pronotal width | 0.39 | 0.35 | 0.5 |

**2nd nymphal instar:** (Figs. 4C and 6C). *Rh. sparsus* and *Rh. bengalensis:* Brownish, closely resembles 1st instar excepting the following changes of characters; mesonotal brown colour reduced and confined to its anterior part; anterior abdomen with deep brown band (for yellow-red band of 1st instar) sparsed with pale small dots; dark brown patches present between dorsal scent gland openings of abdomen; 1st antennal segment with deep blackish annulation; pro- and mesonotum with lateral ampliation; fore femora black with single prominent spine; abdominal margins with brown patches at 2nd-3rd and 3rd-4th terga; labium reaches 3rd coxae.

*M. uniguttatus*: Dirty pale; head, thorax deep brown; first four tergal segments of abdomen pale yellow, rest dull red; sternum and abdomen ventrally pale; single seta present on each side of pro- and mesonotum; one pair of bristles on anal segment persists; some morphological changes from the 1st instar are, darker pro- and mesonotum with ampliate lateral margin; 'Y' suture present; labium reaching 3rd abdominal segment.

| | *Rh. sparsus* | *Rh. bengalensis* | *M.uniguttatus* |
|---|---|---|---|
| Body length | 1.83 | 2.03 | 2.99 |
| Head width | 0.51 | 0.48 | 0.65 |
| Max. pronotal width | 0.56 | 0.56 | 0.71 |

**3rd nymphal instar:** (Figs. 4D and 6D). *Rh. sparsus* and *Rh. bengalensis*: Brownish, resembling the 2nd instar nymph but larger and glossy; a few changes are, light brown colour of head and pronotum; well developed brownish mesonotum sparsed with few pale-yellow dots; tiny pale buds of meso-thoracic wing pads; brown markings around dorsal adbominal scent gland openings much dilute and sparse with pale dots; labium just reaches 2nd coxae; 2nd fore femoral spine developing.

*M. uniguttatus*: Ant mimic; 'Y' suture very prominent lined with dark stripes; 1st and 2nd tergal segment dark brown, 3rd and 4th relatively light and the rest light red; mesothorax shows posterior extension of wing pads, covering anterior part of metathorax; labium reaches 3rd abdominal segment; older 3rd instar nymphs are darker; setae on head, thorax and anal segments and median pale line of thorax obscure.

| | *Rh. sparsus* | *Rh. bengalensis* | *M.uniguttatus* |
|---|---|---|---|
| Body length | 2.76 | 2.94 | 4-.13 |
| Head width | 0.69 | 0.68 | 0.85 |
| Max.pronotal width | 0.83 | 0.86 | 0.86 |

**4th nymphal instar:** (Figs. 4E and 6E): *Rh. sparsus* and *Rh. bengalensis*: General appearance brown, mixed with pale yellow and abdomen with tint of red; perceptible changes over 3rd instar are the arborescent designs of brown and pale markings on head, pro- and mesonotum; mesothoracic wing pads well developed which cover almost whole of the metanotum; tibiae with rows of well developed bristles; antennal and labial segments largely (mostly) brown; fore femora with two prominent and few budding spines; major part of femora, tibiae and distal tarsal joint brown.

*M. uniguttatus*: Ant mimic; back with reddish abdomen; head, pro- and mesonotum black; 1st and 2nd abdominal segment blackish; 'Y' suture prominently lined with white stripe, dark patch between 2nd and 3rd scent gland openings of abdomen; wing pads extend up to 1st abdominal segment; small fine setae on head, pro- and mesonotum; single spine in anterior femora well developed and small spines present on tibiae; labium reaches posterior coxae.

| | *Rh. sparsus* | *Rh. bengalensis* | *M.uniguttatus* |
|---|---|---|---|
| Body length | 3.64 | 4.07 | 5.91 |
| Head width | 0.92 | 0.9 | 1.13 |
| Max. pronotal width | 1.25 | 1.27 | 1.23 |

**5th nymphal instar:** (Figs 4F and 6F). *Rh. sparsus* and *Rh. bengalensis:* Pale brown differs from 4th instar in having triangular head designed with brown markings on pale yellow; trapezoidal pronotum with laminated ampliated margins and variegated designs made of yellow, brown and red patches; mesothoracic wing pads underlined by metathoracic wing pads extend beyond middle of 3rd abdominal segment; scutellar impression present in between the wing pads; femora with black punctures and six or more prominent spines.

5th instar nymphs of *Rh. bengalensis* differ from that of *Rh. sparsus* in the following characters; Trochanter of anterior leg pale as compared to black; anterior and lateral part of metapleuron with an obscure pale spot; overall dorsal appearance paler; pair of blackish patch in mid dorsal region of anterior and posterior margin of pronotum obscured by suffused pale small spots (dots) as compared to prominent and broad black patches in the same position, without any pale spot (Fig. 5).

*M. uniguttatus*: Ant mimic, older nymphs black; 2nd and 3rd coxae, trochanter, proximal femoral region pale; 1st and 4th rostral segment black; 4th antennal segment with a white ring; head, pro- and mesonotum, wing pads and first three abdominal segments black; rest of the abdomen with dirty pale spots; pro- and mesonotum with setae; wing pads extend up to the middle of the 3rd tergal segment; labium reaches 4th abdominal segment; fore femur with four prominent spines and all tibiae with spinous setae.

| | *Rh. sparsus* | *Rh. bengalensis* | *M.uniguttatus* |
|---|---|---|---|
| Body length | 5.3 | 5.36 | 8.1 |
| Head width | 1.1 | 1.1 | 1.46 |
| Max. pronotal width | 1.76 | 1.73 | 1.84 |

**Adults:** (Figs. 4G and 6G). Morphology of *Rh. sparsus* is adequately described by Distant (1904) and *Rh. bengalensis* by Distant (1910); *M. uniguttatus* is described by Thunberg (1822) and subsequently repeated by Distant (1904) in Fauna of British India, Rhynchota. So, the description of the adults are not unnecessarily repeated here. However, a comparison of their morphological measurements (averages) is provided.

| | *Rh. sparsus* | *Rh. bengalensis* | *M.uniguttatus* |
|---|---|---|---|
| Body length | 6.89 | 5.95 | 12.40 |
| Head width | 1.25 | 1.14 | 1.76 |
| Max. pronotal width | 2.23 | 2.05 | 2.91 |

**Enemies and defence:** Birds like Common Myna [*Acridotheres tristis* (Linn.)], Magpie Robin [*Copsychus saularis* (Linn.)], domestic chicks, at times Fivestriped Squirrel (*Funambulus pennanti* Wroughton) and also probably skinks and toads picked *Rh. sparsus* and *Rh. bengalensis* from the litter. The enemies of *M. uniguttatus* could not be properly observed. Though a number of predators like spiders, mantids, reduviids, anthocorids and geocorines (predatory lygaeids) were little noticed yet these invertebrates had an appreciable capacity to attack soft-bodied nymphs of *Rhyparothesus* and *Metochus* species, and a few other lygaeids like *Botocudo* and *Appolonius* of the same litter habitat as well.

The defence mechanism of adults and advance nymphs of *Rh. sparsus* and *Rh. bengalensis* seemed to be their sordid concealing colour, that exactly matched the background of dry leaves and fruits in the litter. So, in still condition these were indistinguishable from the substrate below. *M. uniguttatus* however, tried to find cover to avoid enemy, in cracks, crevices, under stones or litter particles. Another mode of defence was by escaping, when disturbed, by scattering at bewildering speed, so that the enemy got too puzzled to concentrate on any one of them. After feeding, the *Rhyparothesus* spp. often took refuge in inaccessible crevices or inside leaf rolls to escape notice. A special kind of defence mechanism was by adopting mimicry. The shape and the colour of the 1st and 2nd nymphs of *Rhyparothesus* spp., especially their dirty yellow abdomen, highly resembled and matched the mature fig seeds, so that, when feeding on exposed fruits, they were indistinguishable. Adults and advanced nymphs of *M. uniguttatus* were observed to have very close resemblance to different ant species, mantid nymphs, and spiders (since the latter also mimicked ants of the same habitat).

**Variation in size and colour:** The colour of *Rh. sparsus* and *Rh. bengalensis* seemed to depend on the season and availability of food. In drier seasons the bugs generally had a darker shade and grew smaller in size. The variation of size within the same population was more evident in *Rh. bengalensis* than in *Rh. sparsus* or *M. uniguttatus*. Nevertheless, in the latter species sexual dimorphism was noticeable. Thangavelu (1978b) reported antennal oligomery in

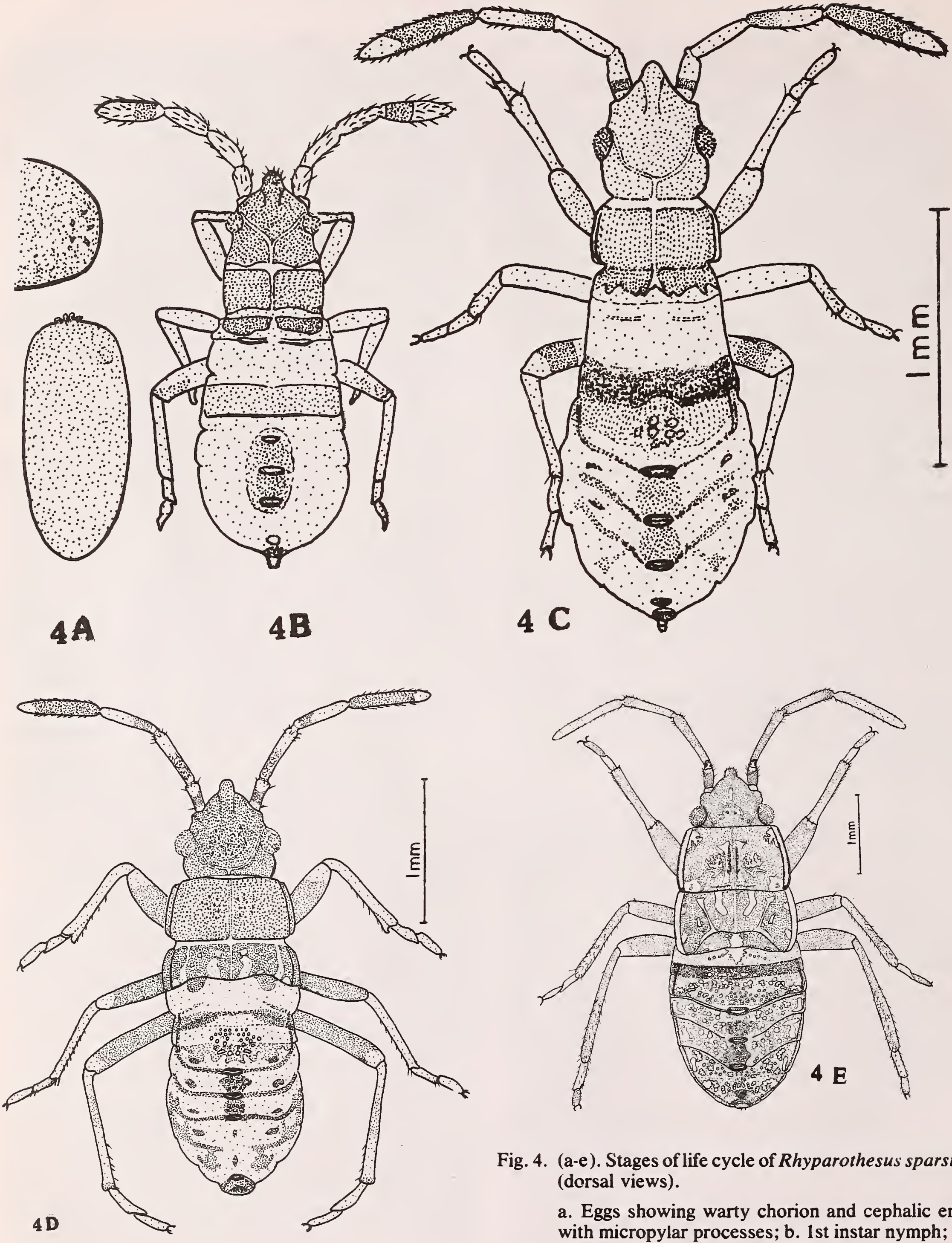
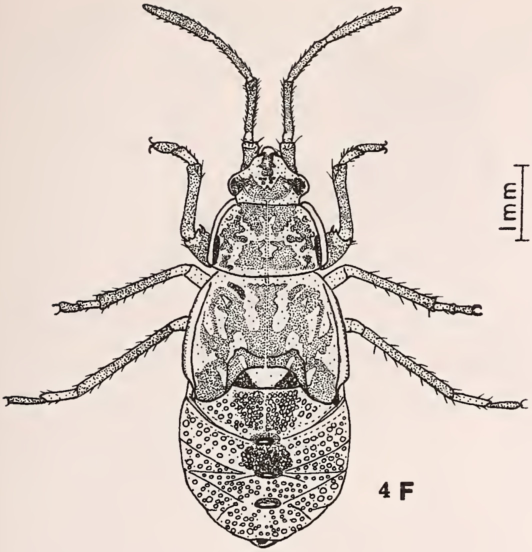
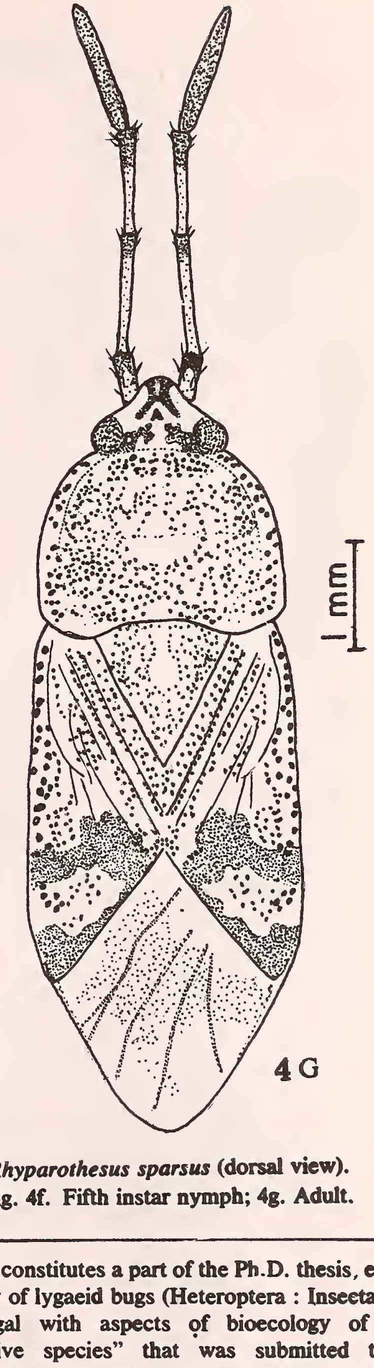


Fig. 4. (a-e). Stages of life cycle of *Rhyparothesus sparsus* (dorsal views).

a. Eggs showing warty chorion and cephalic end with micropylar processes; b. 1st instar nymph; c. 2nd instar nymph; d. 3rd instar nymph.
e. 4th instar nymph.



4 F



4 G

*Rhyparothesus sparsus* (dorsal view).
Fig. 4f. Fifth instar nymph; 4g. Adult.

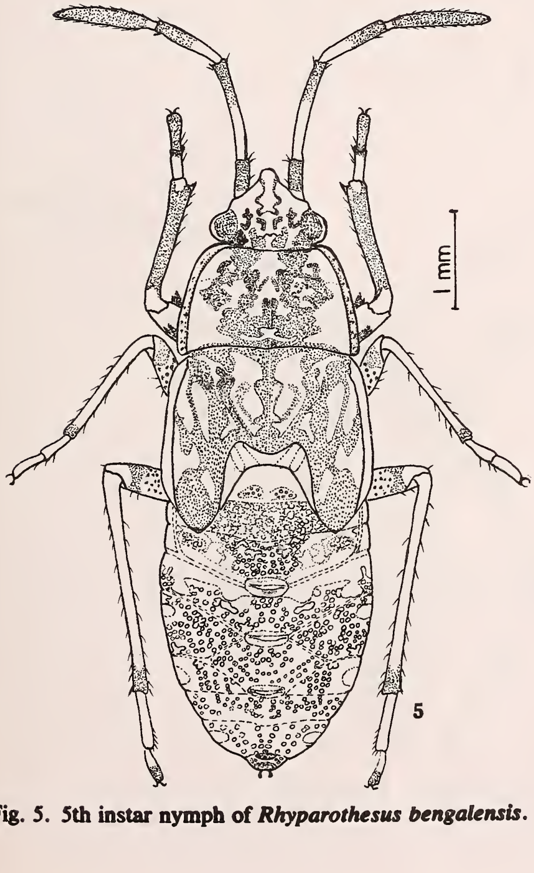


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Fig. 5. 5th instar nymph of *Rhyparothesus bengalensis*.

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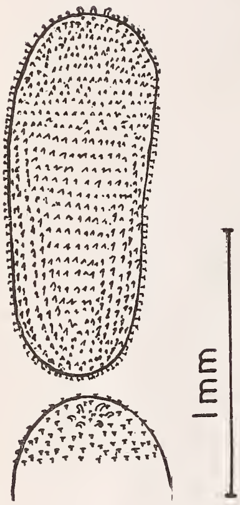
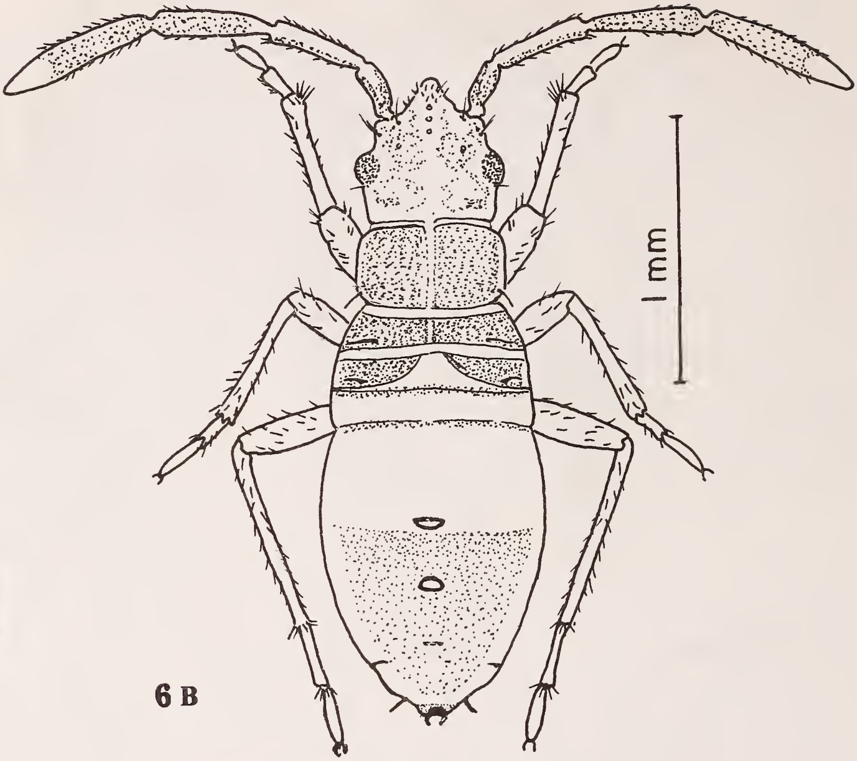
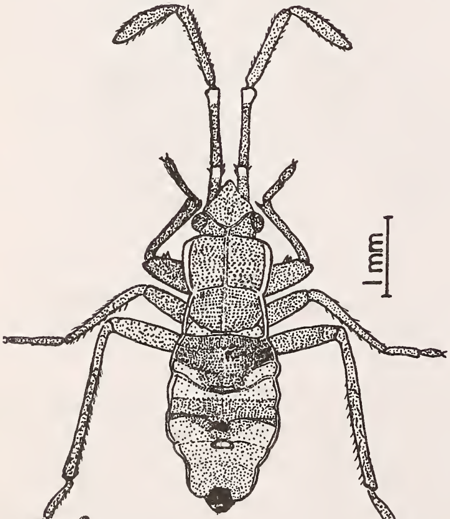
[1] This paper constitutes a part of the Ph.D. thesis, entitled "Taxonomy of lygaeid bugs (Heteroptera : Inseeta) from West Bengal with aspects of bioecology of some representative species" that was submitted to the University of Calcutta with the subsequent award of the degree in 1983. The project was financed by Dept. of Science and Technology through Zoological Survey of India fellowship during the period 1978 to 1981.



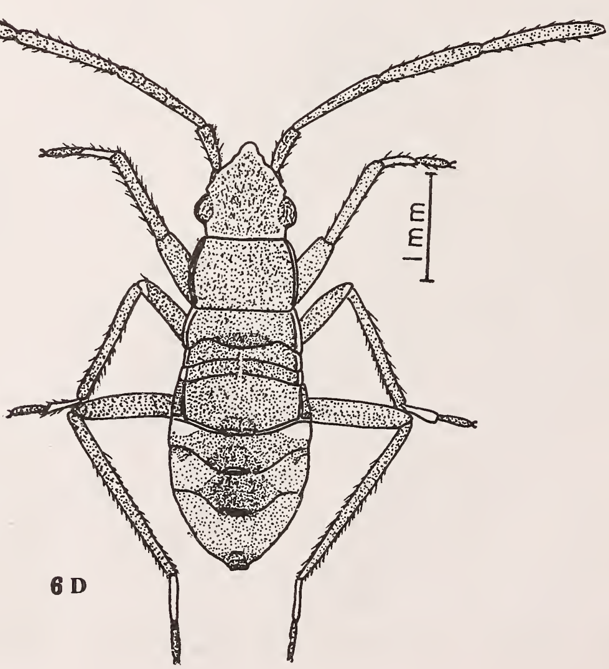
**6 A**



**6 B**



**6 C**



**6 D**

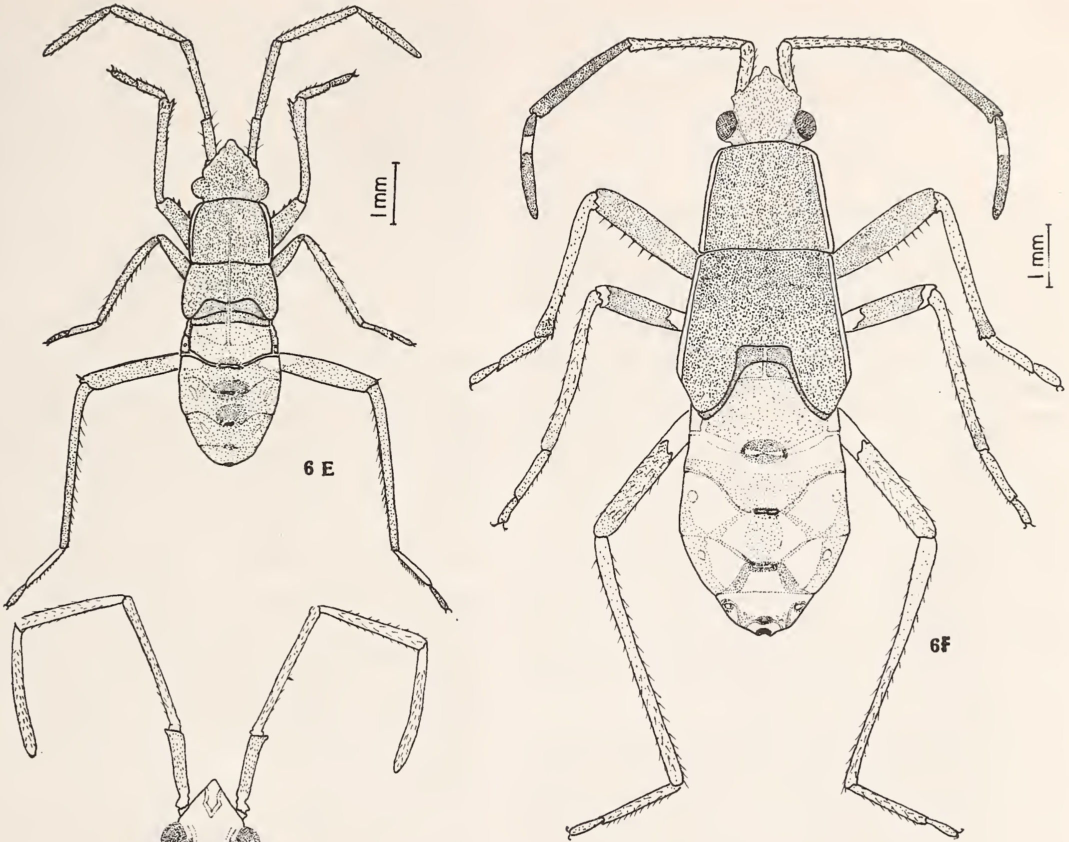


Fig. 6. (a–g). Stages of life cycle of *Metochus uniguttatus* (dorsal view).
a. Eggs showing cylindrical structure and circlets of micropylar processes; b. First instar nymph; c. Second insta nymph; d. Third instar nymph. e. Fourth instar nymph; f. Fifth instar nymph; g. Adult.

populations of *M. uniguttatus* from south India but no such variation was evident from West Bengal. Only a few nymphs of *Rh. sparsus*, however, showed three segmented antennae.

## DISCUSSION

The two species of Rhyparochrominae, *Rhyparothesus bengalensis* and *Rh. sparsus*, that are chiefly confined to the fig litters and litters of a few other plant families of the tropics, have so far been found endemic to the Indian subregion. The possibility of their presence in other tropical countries of the Orient, where the typical host plants exist, is fair; due to lack of extensive survey and intensive search for these procryptic forms in the litter habitats, particularly in the fruiting seasons, the nature of their true distribution is unknown. The more active and polyphagous rhyparochromine, *Metochus uniguttatus*, because of its fast running and flying activities probably has a wider distribution in the tropics and subtropics, namely China, Philippines, Indochina and Indonesia (Slater 1964).

The occurrence of all the three species in the fig litter habitat is principally governed by the availability of food rather than ambient condition. The fig-litter though apparently gives the impression of a permanent habitat is in reality a temporary one. However, for breeding they prefer moderate temperature of spring and autumn synchronized with the availability of food. So, these seasons suited laboratory rearing ideally.

Slater (1972) while studying the fig trees and the associated lygaeid fauna in South Africa and West Indies observed that various species of birds and monkeys regularly fed on the fig fruits. Almost a parallel situation was observed for the *Ficus* spp. in lower West Bengal. The birds and mammals were greatly responsible for preparing the temporary (subclimax) fig-litter habitat congenial to feeding and breeding activities of the lygaeids. The major associated species of birds and mammals during their feeding activity (list provided in appendix 1) wasted and dropped much of the fruits from syconium. Even their droppings (faeces), containing undigested or semi-digested seeds, formed an important dietary item of the litter lygaeids. So the commensalistic role of these vertebrates was quite apparent.

As a member of pentatomorpha, lygaeid eggs lack a true operculum and have an anterior ring of varying number of micropylar processes (5-9) for sperm passage and air exchange (Sweet 1964). The micropylar processes of the three rhyparochromine species ranged between 5 to 7 and, therefore, are in conformity with the above information.

Sweet (1964) observed for rhyparochromines that the embryonic cuticle in all cases were shed after complete emergence from eggs. However in the present study the reason for rupture of the embyonic membrane at different stages, like when the nymph is well inside the chorion, when half its way out, or after complete emergence could not be properly understood. Another difference noticed was that the successful hatching took place simultaneously with nymphal mortality from the same batch of eggs of the same female, the latter taking place when the wriggling nymphs were unable to free themselves of the embryonic membrane, probably due to stiffening of the membrane by drying.

The egg-laying habit of *Rh. sparsus* and *Rh. bengalensis* agrees with Sweet's observation (1964) on litter dwelling New England rhyparochromines. These bugs mostly preferred loose soil for laying. In order to choose oviposition site, as already described, the bugs stimulated the sensory hairs of their ovipositors by repeated probing and lifting the egg-laying organ in the form of plough on the soil surface, which was followed by oviposition. The egg-laying trend of the three rhyparochromines showed a general pattern, with a steady increase in the number of eggs/day/ female in first half of the oviposition period and a steady decline in the second half (Fig. 1). However, *M. uniguttatus* at the end of the oviposition period had a steep decline in the rate of egg laying, which may be due to the mortality of most females in laying condition as these were reared on *Ficus hispida* fruits, probably a not much preferred host plant or not an ideal one for stimulating oviposition.

Eyles (1963) indicated that the nymphs of several species of *Scolopostethus* were not distinguishable in the field and the larval body measurements were similar in all the species studied in the genus. Almost a parallel example of this paradoxical situation are the immature stages of the two species of *Rhyparothesus, Rh. sparsus* and *Rh. bengalensis* almost sharing the same ecological niche. The first four instars having very close similarities, even had their morphometrics overlapping.

Unlike Sweet's (1964) observation of a longer development period for smaller bugs, *Antellocoris*, and shorter for the larger species of *Ligyrocoris*, the overlapping ranges of the post embryonic development period of the three species suggests that the development rates may be dependent on the adaptations to the habitat, food, seasonal cycles, and surrounding conditions, but not to the size of the rhyparochromine bugs.

As none of the three species showed any preference for probing any particular site of a seed, it is probable that they feed on the endosperm and the embryo indifferently, unlike one that is found in *Drymus sylvaticus* that only feeds on the embryo of seeds (Eyles 1964).

The extreme example of seed defence behaviour was where the bugs fight physically over a seed, as observed by Sweet (1964) for *Pachybrachius*. This was found to be common among the males of *Rh. sparsus* and *Rh. bengalensis*, who sometimes fought even without a seed in possession, thus indicating that such disputes were not always over food directly but possibly over territory of feeding and stored food safety.

The rhyparochromines in general show mating behaviour where the male vibrates the antennae rapidly near the female and climbs upon her deliberately (Sweet 1964). The two *Rhyparothesus* species showed no exception to this habit, but because *M. uniguttatus* produces a feeble sound by stridulating hind tarsi against hemielytral surface (Thangavelu 1978a) it is likely that the sound is involved neither in offence nor defence but in courtship. So, mating behaviour of this rhyparochromine would better fit a different category where the male employs a forefemoral activity (stridulations) and vibrating antennae, as has been suggested for the long-legged Myodochini by Sweet (1964).

While some ant mimicry of interest from Indian subregion is reported by Thangavelu (1978a) there seems to exist certain mimicry complex in some of the fig-litter habitats as observed in West Bengal. Ants, spiders, nymphs of mantids, and adult and nymphal lygaeids often coexisted with close mimicry. All showed a convergent adaption, but it was difficult to ascertain the model and the mimic in such a situation. Conventionally, however, ants might be taken as a model since most nymphs of mantids *Gonypeta* sp., and most adults and nymphs of lygaeids like *Pachybrachius pallicornis, Metochus uniguttatus, Pseudopachybrachius guttus*, and *Appolonius* spp. resembled one or the other species of ants of the same habitat. *Gonypeta* sp. which predated on other insects might be thought to have aggressive mimicry in resembling the ant *Diacamma vagans*; such resemblance was also found common in an ant-like spider of the same habitat.

Colour and size variations observed in *Rh. sparsus*, and *Rh. bengalensis* seem partly due to the change in the same habitat, and the state of food and moisture available at different seasons. The light and dark shades of the same bug may be due to change in its physiology that depends on its diet.

So, the study of the life styles of the three commonly occurring rhyparochromine bugs of the fig-litters reflect certain important ecological aspects that also hold good for most other seed-feeding bugs of the same habitat. Apart from their untiring role as reducers and secondary decomposers of litters to replenish the soil nutrients, their noble involvement in seed dispersal because of their seed-defence behaviour has to be appreciated in context with today's crying need for expansion of mixed type forests to restore the environmental balance.

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## APPENDIX 1

### LIST OF HIGHER VERTEBRATES PARTICIPATING IN COMMENSALISM

| Common Names | ScientificNames |
|---|---|
| *Birds* | |
| Common Myna | *Acridotheres tristis*(Linn.) |
| Greyheaded Myna | *Sturnus malabaricus*(Gemelin) |
| Large Green Barbet | *Megalima zeylonica*(Gmelin) |
| Coppersmith or the Crimsonbreasted Barbet | *Megalaimahaemacephala* |
| Koel | *Eudynamys scolopacea* (Linn.) |
| Common Green Pigeon | *Treron phoenicoptera*(Latham) |
| Redvented Bulbul | *Pycnonotus cafer*(Linn.) |
| Redwhiskered Bulbul | *Pycnonotus jocosus*(Linn.) |
| Grey Tit | *Parus major* Linn. |
| *Mammals* | |
| 1. Fivestriped Palm squirrel | *Funambulus pennanti* Wroughton |
| 2. Fruit Bat | *Cynopterus sphinx* Vahl |

# DIET OF THE SMOOTH INDIAN OTTER (*LUTRA PERSPICILLATA*) AND OF FISH EATING BIRDS; A FIELD SURVEY[1]

CHRISTINE TILER, MEGAN EVANS, CLARE HEARDMAN AND SUSAN HOUGHTON[2]

(*With six text-figures*)

A five month field study of the smooth Indian otter *(Lutra perspicillata)* was carried out, beginning mid October 1984. It took place within the Royal Chitwan National Park, which is situated in the belt of subtropical jungle of the terai, Southern Nepal. The seventy-five kilometre stretch of the Narayani River which runs within the Park was surveyed for otter spoor. A survey of the fish population was also carried out in order to identify the fish species present and their distribution. The results of the otter survey are reported here. A total of 172 spraints were collected and the faecal components analysed. The remains of fish, frog, crab, insect and small mammals were identified. The relative importance of the major dietary components was compared along the length of the river. In the southernmost sections surveyed fish were much more common in the diet, whereas further north frogs became increasingly more important.

By the comparison of distinctive fish remains with a reference collection compiled during the course of the fish survey, it was possible to identify to species level the remains of some fish. Of a total of seventy fish species captured during the course of the study, twenty-six were identified from pharyngeal teeth and dorsal spines recovered in faeces. Fish vertebrae were measured to give an index of prey size.

The regurgitated pellets produced by fish-eating birds were dissected to give an indication of fish species eaten and their size range, and to enable comparison between birds and otters. The data suggests birds predominantly predate small, shoal-living fish.

## INTRODUCTION

The smooth Indian otter is only found within southern Asia. A survey by Wayre (1971) has shown the species to be nearly extinct in Pakistan, becoming rare in Thailand, and only abundant in less populated areas of Malaysia. Its status elsewhere in Southern Asia is unknown. In Nepal, this species is known to exist in the Royal Chitwan National Park, and in the Karnali reserve in the West of Nepal (K.K. Gurung, personal communication). Within its range the smooth Indian otter inhabits both coastal and freshwaters, the latter being preferred, and is said to require for its territory approximately eight to ten kilometre stretches of river (Wayre 1974).

No detailed studies to date have been done on the diet of the smooth Indian otter in its natural habitat. Most dietary studies have been on species belonging to the genus *Lutra* but mainly on the common otter *(Lutra lutra)* and sea otter *(Enhydra lutras)*. Since otters are difficult to observe, most dietary studies have been done indirectly by faecal analysis.

This paper reports on the survey of this species distribution within the Royal Chitwan National Park, and on the results of faecal analysis.

## METHODS

Between mid October 1984 and the end of February 1985 the seventy-five kilometre stretch of the Narayani river within the Park was surveyed to assess the distribution of the smooth Indian otter. During the survey both river banks were searched on foot for spoor. The position of spraints was recorded as well as their size and association with habitat features. Subsequent to collection spraints were washed in a fine sieve and left to dry in the sun. They were then individually dissected and the various components separated. In some cases

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it was possible to identify from which fish species pharyngeal teeth and dorsal spines originated by comparison with a reference collection of identified, boned fish which was compiled during the course of the study.

A similar technique was used to determine the composition of regurgitated pellets left along the river bank by fish eating birds. This facilitated a comparison of the species taken by each group of fish predator.

Fish vertebrae found in otter spraints and bird pellets were measured along their anterior-posterior axis to give an indication of the size ranges of prey.

## RESULTS

**Spoor Distribution:** For the purpose of this study the Narayani was divided into eight sections (figure 1). Otter spoor were found along the entire length of the Narayani within the Park with two exceptions:

(i) in November no signs were found in regions one, two and three, but by January they were plentiful in these regions;

(ii) no signs were found in region eight.

Otter signs were found both on banks inside and outside the Park boundary although no holt or play sites were found in the cultivated area outside the Park boundary. Spraints were collected from one of two types of sprainting sites which differed in a number of respects:

(i) *single spraints*. These were found almost exclusively on prominant rocks, logs, or scraped up mounds. Single spraints could be as close as one and a half metres apart and tended to be situa-

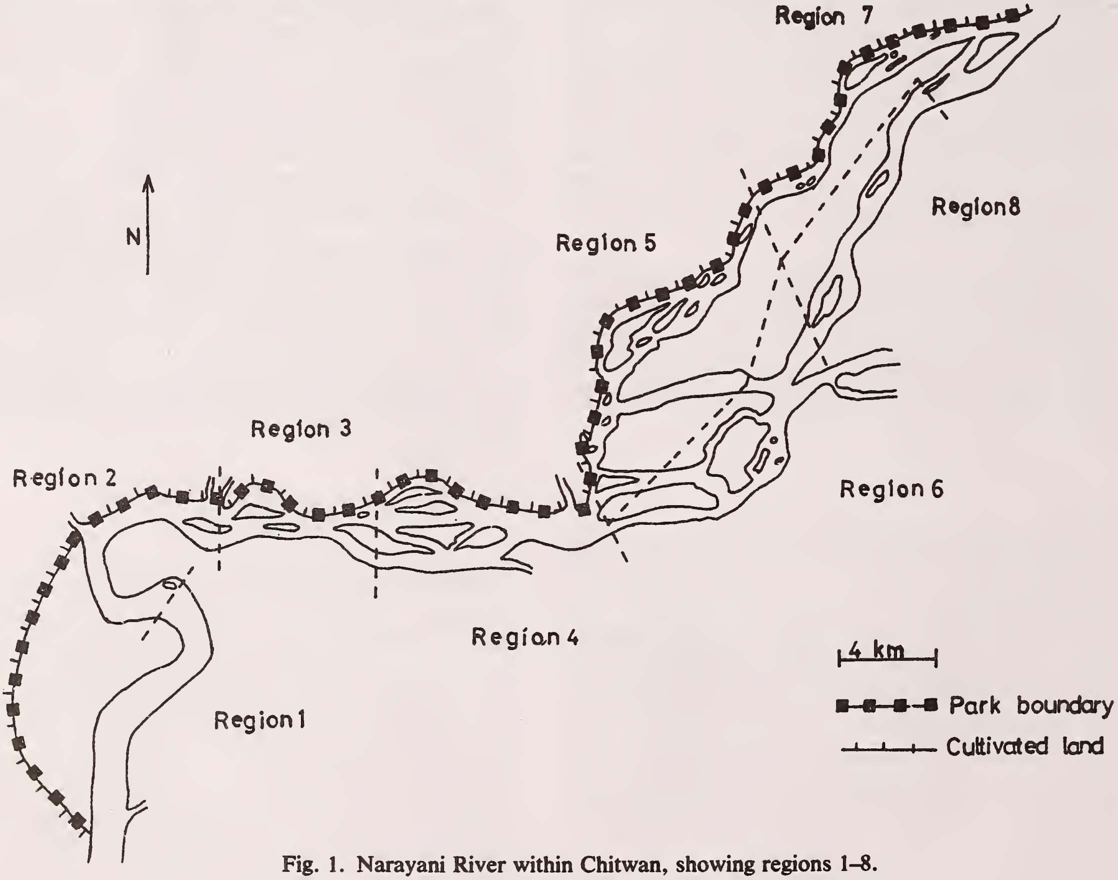

Fig. 1. Narayani River within Chitwan, showing regions 1–8.

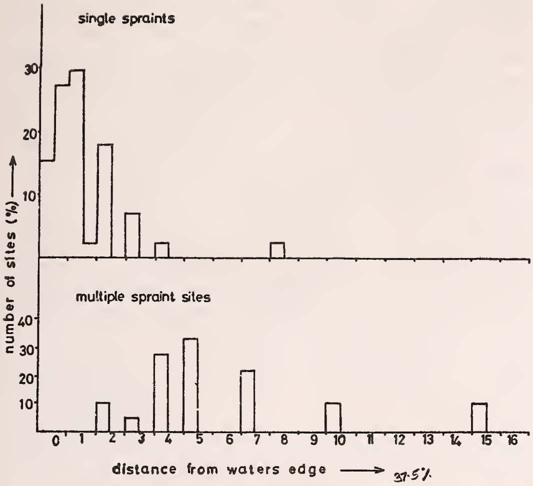

**Fig. 2. Relationship between the two spraint types (single and multiple spraint sites) and distance from the river.**

ted within three metres from the river's edge (figure 2).

(ii) *multiple spraints*. These were found on dry sandy banks or sand and shingle banks, sometimes marking river confluences. Larger sites were found at least fifty metres apart and in general were further from the water's edge (figure 2).

The sprainting behaviour of the smooth Indian otter is similar to that of other members of the genus *Lutra,* in particular to that of the common otter *(Lutra lutra)* in Britain.

**Spraint Analysis:** Within each of the regions one to eight the spraint data was summed and represented by the pie graphs in figure 3. Spraint components were fish, frog, shrimp, crab, insect, snake and small mammal. The proportions of the dietary components found in the faeces varied between regions. In the southernmost regions, one and two the predominant remains found in spraints were from fish (ninety-four per cent and seventy-six per cent respectively). Progressing north of region two frog bones were increasingly common in spraints, comprising as much as fifty-eight per cent in region seven. The remains of other prey such as crabs, shrimps, snakes and insects were also more common in spraints north of region two.

Twenty-six of the commonest fish species could be identified to species by examination of pharyngeal teeth and distinctive spines. Other workers have used various types of undigested fish remains for identification purposes. These include fish scales (Webb 1978), vertebrae (Wise 1980) and pharyngeal teeth.

As well as being identified, teeth were measured. For any spraint, if two sets of teeth from the same species were of the same size and from opposite sides of the head then it was assumed both originated from the same fish. Thus an estimate of the minimum number of fish occurring in a spraint was obtained.

Figure 4 shows the frequency with which each fish species was identified from spraints, and the minimum number of fish present in

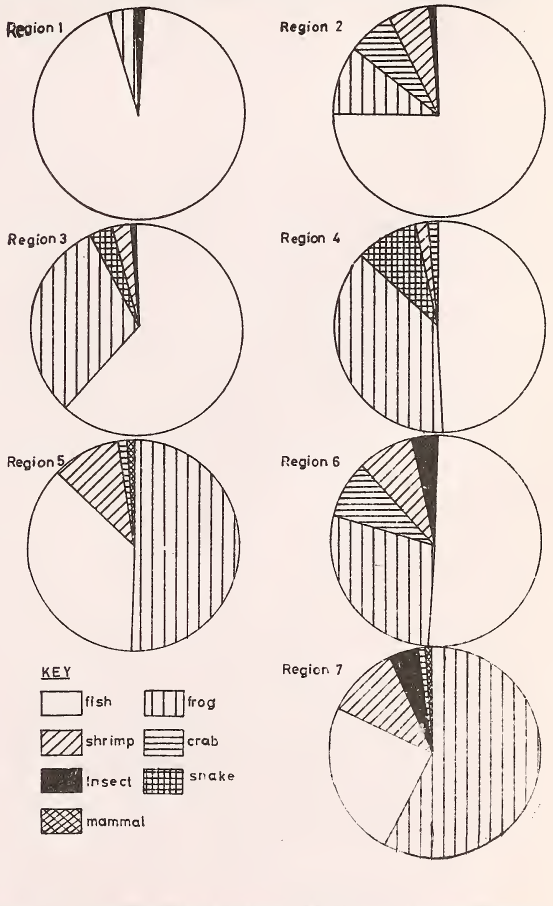

**Fig. 3. Composition of the diet of the smooth Indian otter in regions 1-7 (no samples from region 8).**

each spraint. The results for all regions is summed.

**Comparison with fish-eating birds:** The composition of regurgitated pellets deposited by fish-eating birds was examined in an attempt to assess which fish species were of most dietary importance. The most common species of fish eating birds in the Park are the large cormorant *(Phalacrocorax carbo)*, small pied kingfisher *(Ceryle rudis)*, Eurasian kingfisher *(Alcedo atthis)*, white breasted kingfisher *(Halcyon smyrnensis)*, night heron *(Nycticorax nycticorax)*, pond heron *(Ardeola grayii)*, intermediate egret *(Egretta alba)* and little egret *(Egretta garzetta)*.

Figure 5 shows the frequency with which teeth of each fish species were found in bird pellets. There is considerable overlap in the species taken by otters and birds, although the predominance of teeth from *Puntius* sp., *Barilus* sp., and *Danio devario* in bird pellets suggests a prediliction for small, shoal- living species.

To compare the size-ranges of fish captured by the two groups of predator, vertebrae found in spraints and pellets were measured along their anterior-posterior axis. It has been reported that there is a direct relationship between the size of the vertebrae and the size of the fish

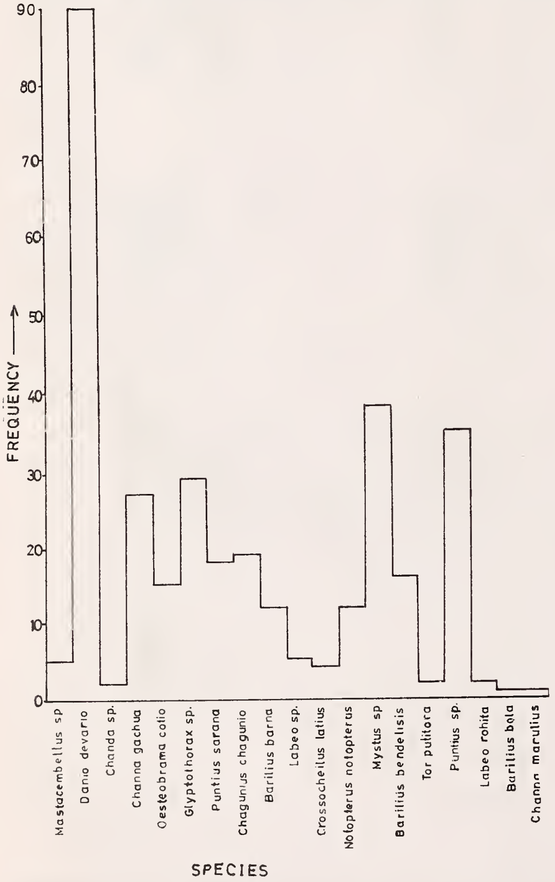

Fig. 4. Frequency with which teeth from each fish species were found in otter spraints.

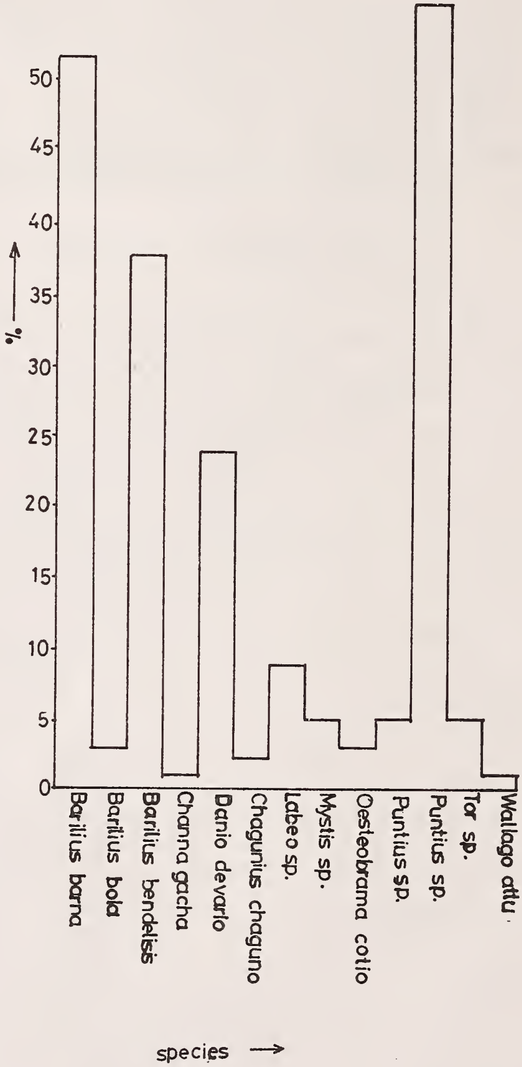

Fig. 5. Frequency with which teeth from each fish species were found in bird pellets.

(Wise 1980). The size ranges of vertebrae found in individual spraints and pellets are plotted in figure 6. Vertebrae found in bird pellets all lay within the range 0.25 - 2 mm, whereas those found in otter spraints ranged from 0.25 - 4.5 mm.

## DISCUSSION

Dietary analysis from faecal component data is an indirect method. As such, the technique is prone to bias, some prey items, notably crustaceans, will have a higher proportion of hard:soft parts and so will be over-represented in the faeces.

Within the seventy-five kilometre stretch of the Narayani under study there is considerable variation in the composition of the otter's diet. In regions one and two the major constituent is fish, further north other components, notably frog, become more important. Dietary differences could be attributable to a number of factors. The river's topography varies, and this is likely to affect both the prey available and the most effective foraging methods. In regions one and two the river runs in a single channel and in many places the banks descend steeply into the water. North of region two the river is braided into a number of channels by islands. Here the river has sandy stretches where the water is slow flowing, and faster flowing regions with a stony river bed. Conditions in regions one and two are favourable for fish requiring a large, deep and slowly flowing body of water. Further north, fish which prefer shallow, fast-flowing water or sandy pools will be more common. Other potential prey species inhabiting the sandy pools include shrimp and freshwater crabs.

Human fishing activity is another factor li-

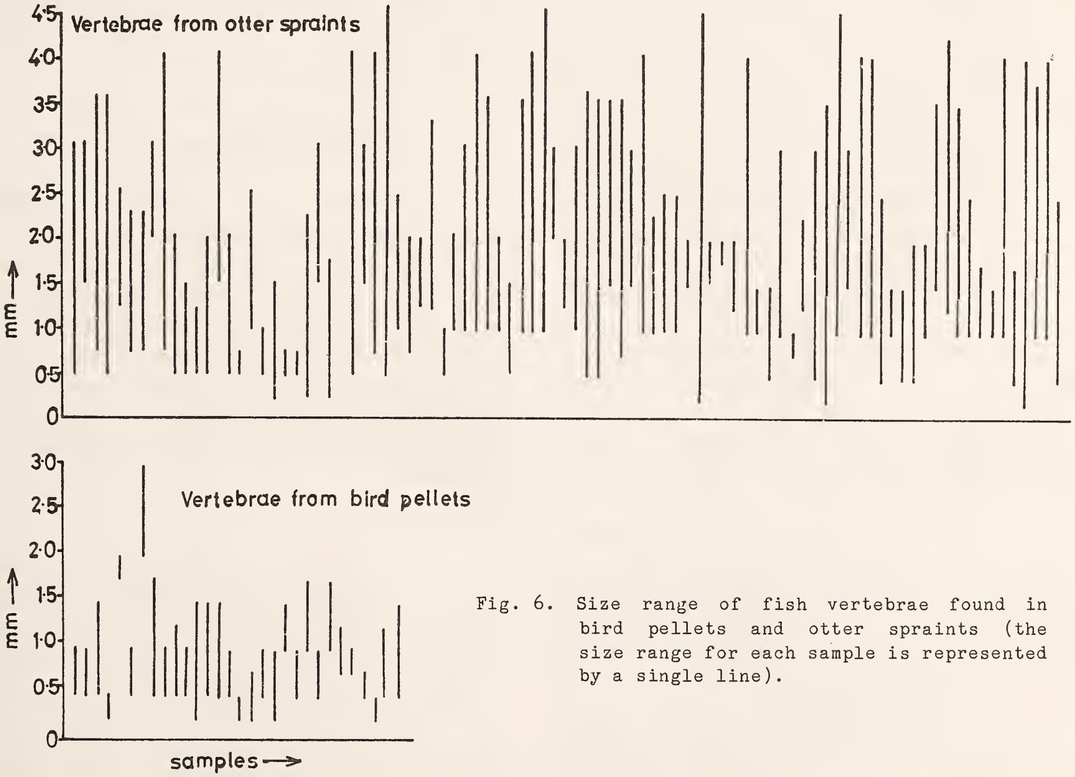

Fig. 6. Size range of fish vertebrae found in bird pellets and otter spraints (the size range for each sample is represented by a single line).

Fig. 6. Size range of fish vertebrae found in bird pellets and otter spraints (the size range for each sample is represented by a single line).

kely to influence the availability of prey. Fishing by local people occurs where the river forms the Park's boundary. This is the case north of region two. The Park authorities prohibit the use of methods particularly damaging to the fish population such as fish traps placed over small tributaries and the practice of damming and draining short sections of the river. However, both these methods which damage fish stocks by removing large numbers of immature fish are still in use in the Park.

Evidence both from local fishermen and our own fish survey (Evans *et al.* 1985) suggests that where there is human access to the river north of region two, stocks are over-fished. By comparison, stocks in regions one and two will not be subjected to overfishing for two reasons. Firstly, human access is restricted by the fact this stretch of the river is bordered on both sides by the National Park. Secondly, the fact the river is broad and deep prevents the use of fish traps and damming and draining methods.

Both the effects of the river's topography and of human fishing activity are consistent with our data, and it is difficult to assess the contribution of each. The considerable dietary variation shown in this study suggests otters are able to exploit a wide range of prey, a valuable attribute where fish stocks are low. However, other predators which rely more heavily on fish, for example the endangered species of crocodile, the gharial *(Gavialis gangeticus)* and the rare Gangetic dolphin *(Plantasia gangetica)* may be more seriously be affected by the results of overfishing.

The identification of fish remains to species level provides precise dietary information on prey items found in spraints. However, this data cannot be used to make inferences about species not positively identified in spraints. There are various reasons why distinctive bone fragments may not appear in the faeces. Particularly fragile teeth are more likely to break during passage through the gut. Distinctive fragments of fish which are not swallowed whole may not appear, for example, the head of *Xenatodon cancila* which is long, bony and full of teeth may not be swallowed. Species without distinctive skeletal features such as *Nemacheilus botia* and *Amblyceps mangois* will not be recognised in spraints.

The fish remains found in spraints suggest the otter predates a wide size range of fish from a variety of habitats. By comparison, bird pellets contained remains from species of fish which remain small throughout their life cycle. Data obtained from the measurement of vertebrae supported the conclusion that otters take a much wider size range of fish species than do fish- eating birds.

## ACKNOWLEDGEMENTS

We are grateful to the sponsors who gave us financial and material support to carry out the study as part of the 'University of Edinburgh Expedition to Nepal, 1985'. We offer our thanks to Dr Hemanta Mishra, of Nepal's National Parks Department for granting us permission to work in the Park and establishing us there. We are particularly grateful to many of the Park staff their valuable guidance and practical help.

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# NEW DESCRIPTIONS

## A NEW SPECIES OF HERMIT CRAB, *DIOGENES KARWARENSIS* (DECAPODA: ANOMURA) FROM THE WEST COAST OF INDIA[1]

V.N. NAYAK[2] AND B. NEELAKANTAN[3]

(*With two text-figures*)

A new species of hermit crab of the genus *Diogenes* from Karwar in the west coast of India is described. The closely related *Diogenes avarus* Heller available in the same habitat is compared.

### INTRODUCTION

The systematics of shallow water hermit crabs have not been studied in detail from Indian waters, except by Henderson, 1893 and Alcock, 1905. Hermit crab species of the genus *Diogenes* are among the most common and abundant components of the intertidal and estuarine regions of Karwar area along the west coast of India. While working on the systematics of the intertidal Paguridae of Karwar area, several specimens of an undescribed taxon resembling *Diogenes avarus* Heller were collected.

### MATERIAL AND METHODS

Specimens used for the description were collected from Baithkol area about 1 km south of Karwar 14° 18' N and 74° 97' E) and Kali estuary, about 3 km north of Karwar. The holotype has been deposited in the Zoological Survey of India Museum (Reg. No. C 3519/2) along with *Diogenes avarus* Heller (Reg. No. C 3520/2), Calcutta and paratype in the Karnatak University Department of Marine Biology Museum (CA/16/82) and Government Arts and Science College Department of Zoology Museum (ACAhc/16), Karwar. The terminologies used for adult description follow Jackson (1913) and McLaughlin (1974).

### RESULTS

**Shell preference:** This species occupies in the collection localities, the gastropod shells listed below in the order of preference.

1. *Cerithidea cingulata* (Gmelin); 2. *Nassarius stolata* (Gmelin); 3. *Umbonium vestiarium* (Linnaeus); 4. *Natica tigrina* (Roeding); 5. *Thais carinifera* (Lamarck).

**Diagnosis:** Ocular peduncle short and stout, approximately one-half the length of shield. Antennular peduncle as long as antennal peduncle, exceeding ocular peduncle in length. Rostral scale simple and spine-like, never exceeding ocular acicles. Ocular acicles spinulose distally. Antennal acicle short, reaching up to distal margin of fourth segment, never exceeding. Left cheliped spinulose; propodus with a short ridge proximally; carpus with 4 moderately long, conical spines on the distal margin.

**Description:** (Figs. 1 & 2): Holotype herein selected, male, shield length, 3.0 mm. Shield width equalling length, occasionally slightly longer than broad; anterolateral margin sloping or slightly terraced; anterior margin between rostrum and lateral margin slightly concave; posterior margin truncate or roundly truncate; dorsal surface smooth; dorsolateral margins with 3 - 4 short, transverse rows of spinules and tufts of short bristles; anterolateral angle very slightly produced. Rostrum short, not exceeding lateral projections, broadly rounded. Rostral scale moderately short, acutely pointed, reaching upto the distal margin of ocular acicle or slightly falling short, never exceeding ocular

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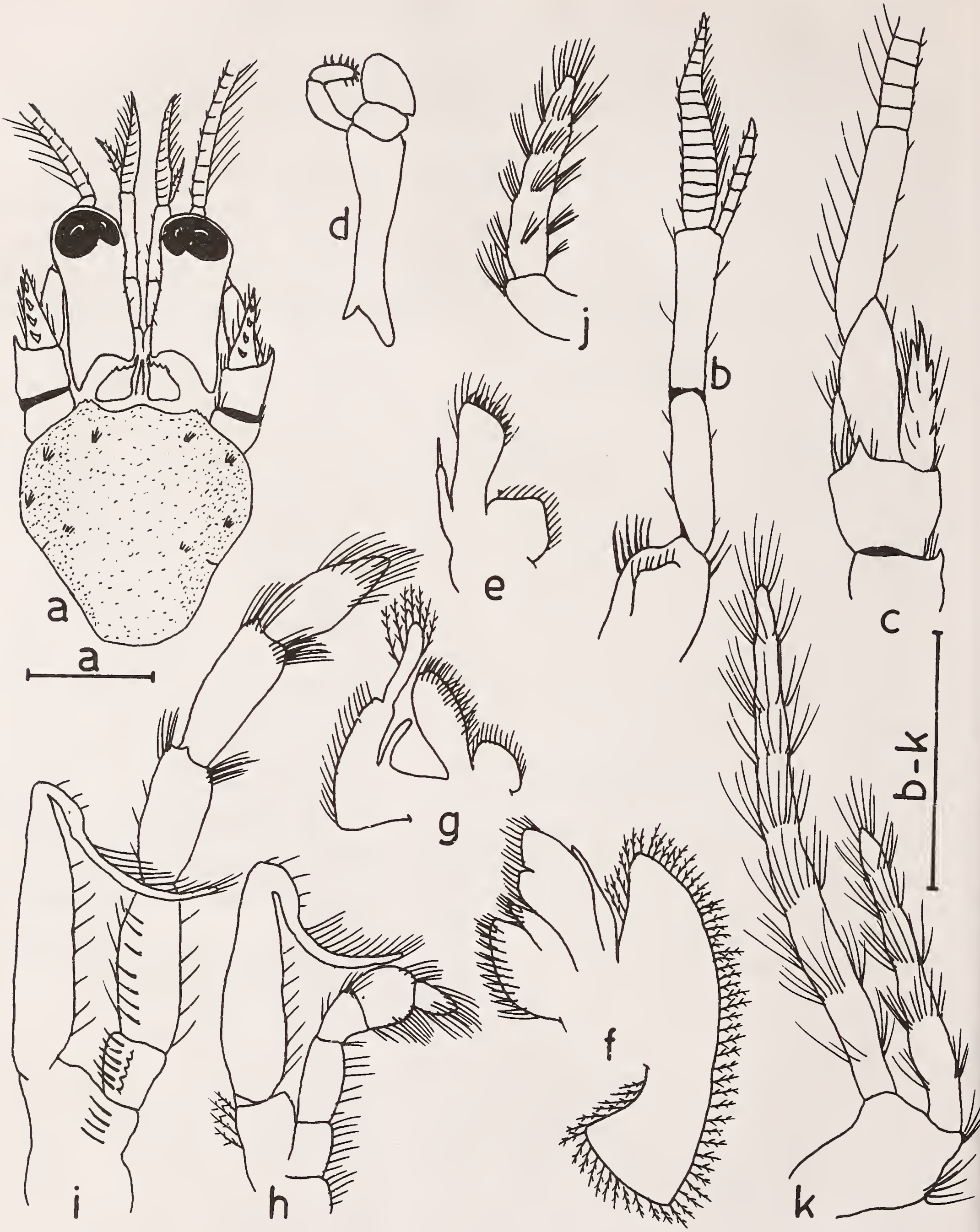

Fig. 1. *Diogenes karwarensis* sp. nov., adult

a. Cephalic shield; b. Antennule; c. Antenna; d. Mandible; e. First maxilla; f. Second maxilla; g. First maxilliped; h. Second maxilliped; i. Third maxilliped; j. Pleopod (male) k. Pleopod (female). Scale: 1 mm.

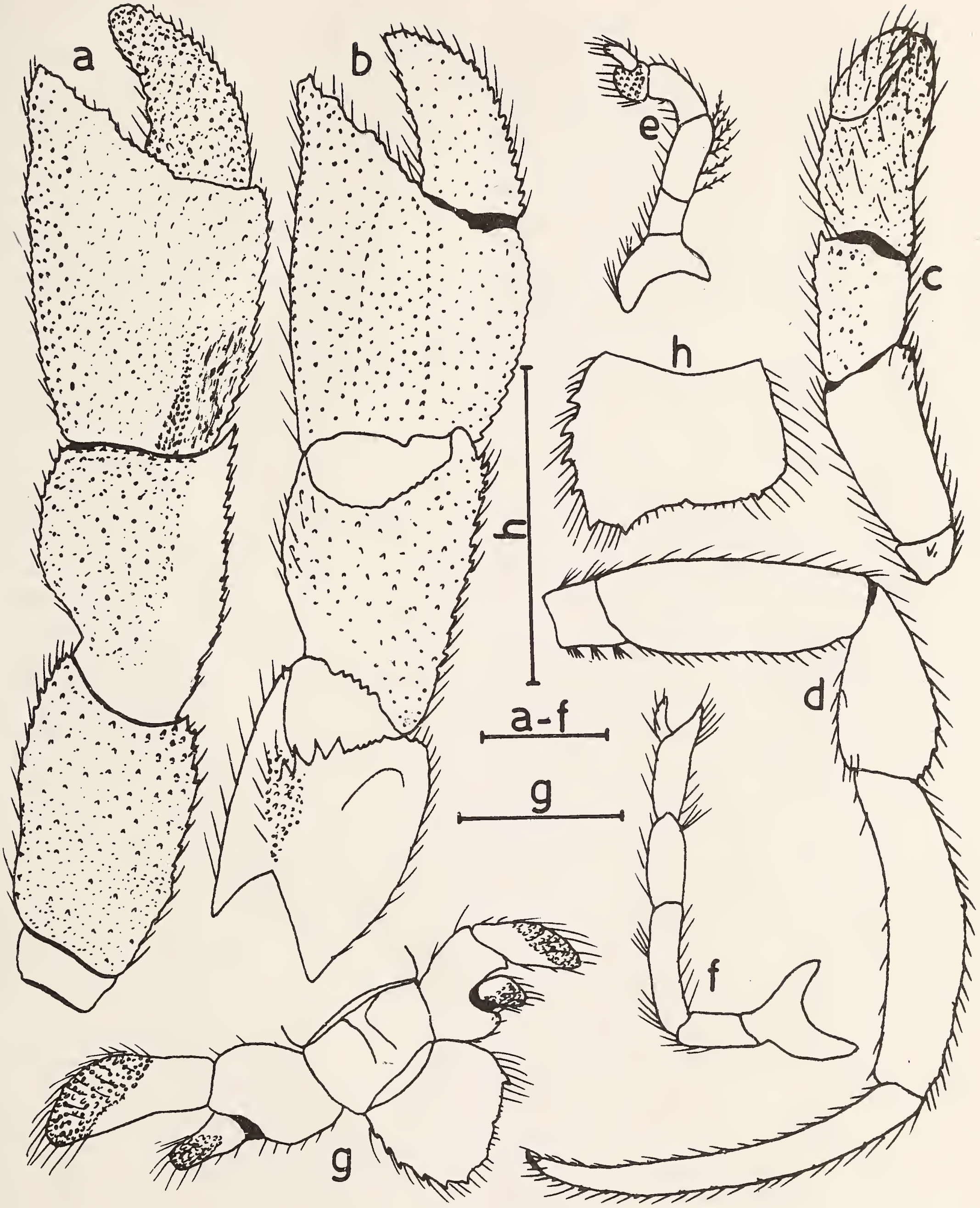

Fig. 2. *Diogenes karwarensis* sp. nov. adult

a. Left cheliped, dorsal view; b. Left cheliped, ventral view; c. Right cheliped; d. Second pereiopod; e. Fourth pereiopod; f. Fifth pereiopod; g. Telson and uropod; h. Telson. Scale: 1 mm.

acicles. Lateral projections broadly triangular, with or without a terminal spinule.

Ocular peduncle short and stout, one-half to two-thirds the length of shield; very slightly inflated basally; somewhat dilated in corneal region; ventral face with a row of tufts of moderately short, plumose setae; corneal portion moderately long, approximately one-fifth the length of peduncle. Ocular acicle triangular, distal margin serrated, spines increasing towards rostral scale, the one nearest being the longest, conical, acute spine, exceeding the distal extension of rostral scale; separated basally by approximately one-half the basal width of one acicle.

Antennular peduncle moderately long, exceeding the length of ocular peduncle by two-thirds to one-half the length of ultimate segment. Ultimate and penultimate segments with very few minute setae; basal segment with a spinule at ventral distal margin; lateral surface and dorsolateral margins with tufts of short setae, dorsolateral distal angle with a row of 3 - 4 spinules. Dorsal flagellum with about 12 segments and ventral with 5 - 6 segments.

Antennal peduncle moderately long, as long as antennular peduncle; exceeding ocular peduncle by three-fourths to entire length of ultimate segment, with supernumerary segmentation. Fifth segment with a row of long, plumose setae laterally and few scattered short setae all over. Fourth segment with a short spine dorsally and very few short setae. Third segment with ventromesial distal angle produced, terminating in a subacute spine and tufts of short setae. Second segment with an acute spine on dorsolateral distal angle and tufts of setae. First segment with a short, acute spine on dorsal face distally. Antennal acicle simple, reaching upto the base of ultimate segment or slightly shorter, somewhat triangular, terminating in a strong, simple or bifid spine; dorsal face with a row of 3-4 strong, acute spines; lateral and mesial margins with rows of moderately long setae. Antennal flagellum long, reaching upto the base of dactyl of large cheliped; articles with long, plumose and short setae; flagellum of about 17 segments.

Mandibles without distinctive characters; palp 2-segmented, distal segment with short, plumose bristles. First maxilla with proximal endite subquadrate or ovately triangular; endopod with a bristle terminally. Second maxilla with endopod inflated basally, exceeding scaphognathite in distal extension. First maxilliped with endopod approximately one-third the length of exopod, reaching upto the distal end of proximal segment; basal segment of exopod somewhat triangular and slender. Second maxilliped with basis-ischium fusion incomplete. Third maxilliped with basis- ischium fusion complete; crista dentata poorly developed with 3 - 5 short spines and a row of stiff bristles; carpus with a spinule on dorsal distal margin.

Left cheliped considerably larger than the right, approximately one and one-half the length of carapace; overreaching pereiopods. Dactyl moderately short, three-fourths the length of palm; fixed finger deflated; overreaching and overlapped by fixed finger, terminating in a calcareous claw; cutting edges with row of strong, calcareous teeth; dorsal surface with a median row of spinules in the distal half and granules scattered all over; dorsolateral and dorsomesial faces with rows of spinules or minute spines; mesial margin with a row of moderately long, subacute spines and tufts of moderately long setae; lateral face with a row of subacute spines; ventromesial face with a row of subacute spines and tufts of moderately long setae; ventral surface with a row of short spines reducing in size distally, very few scattered granules spread in the proximal region. Palm moderately long, as long as or one and one-fifth the length of carpus; dorsal surface convex with a median ridge proximally with irregular rows of acute spines in the proximal half, granules spread all over, more in the median line, forming spinules; lateral face with rows of small spines; mesial face with rows of short, subacute spines and short setae; ventral surface with 2 rows of short spines, subacute spines and granules scattered all over; ventral distal margin with a prominent tubercle near the movable finger. Carpus moderately short, as long as merus; dorsal surface with uniformely scattered short, subacute and acute spines; dorsal distal margin with a row of short spines; mesial margin with a row of prominent, acute spines, increasing in size distalwards;

lateral face with rows of short subacute spines or low tubercles; lateral distal angle with a prominent tubercle; ventral surface with uniformely scattered, irregular rows of subacute spines or low tubercles; ventral distal margin concave with a row of minute spines. Merus moderately long, subtriangular; dorsal surface with irregularly scattered spinules and granules; dorsolateral margin with a row of short spines distally and tufts of setae; dorsomesial margin with a row of short spines increasing in size distally and tufts of setae; mesial distal margin with a row of short spines and tufts of setae; mesial face with very few granules distally; ventral distal margin with 4 long, conical acute spines; ventral surface with short spines or spinules uniformly scattered and tufts of setae; ventrolateral face with irregular rows of small spines or spinules. Ischium moderately short, ventral distal angle produced; lateral face with a low tubercle and 2 - 3 spinules. Coxa short, mesial margin with a low tubercle.

Right cheliped moderately short and slender, reaching up to the base of palm of left cheliped. Dactyl and palm with tufts of setae on all faces. Dactyl moderately long, one and one-third the length of palm; cutting edges with a row of short tubercles; leaving a gap when closed, ending in a calcareous claw; dorsal surface with irregular rows of subacute spines or low tubercles; lateral face with irregular rows of spinules or low tubercles; mesial face with rows of short spines or spinules; ventral surface unarmed. Palm moderately short, as long as carpus; dorsal surface with rows of short spines; lateral face granulose; mesial face with granules; ventral surface with spinules distally and few granules proximally. Carpus three-fourths the length of merus; dorsal surface with irregular rows of spinules and few tufts of short setae; dorsomesial margin with a row of acute spines increasing in size distally and tufts of setae; mesial face with very few granules; ventral distal margin with a row of spinules; ventral surface with tufts of short setae; lateral face granulose. Merus moderately long, subtriangular; dorsal margin with minute granules and tufts of setae. Mesial face even and unarmed; lateral face even, unarmed except for very few granules; ventral surface with few granules and tufts of setae. Ischium short, ventral distal angle produced; unarmed except for tufts of setae. Coxa with very few granules ventrally.

Second pereiopod falling short of left cheliped, right slightly longer than the left. Dactylus moderately long, one and one-fifth the length of propodus; in lateral view turned ventrally; in dorsal view straight; terminating in a short, corneous claw; dorsal surface with moderately short setae and a row of spinules only in the distal half; mesial and lateral faces unarmed; ventral surface with a row of short setae and rarely a row of spinules. Propodus moderately long, one and one-half the length of carpus; dorsal surface with a row of spinules and a row of short setae; lateral and mesial faces unarmed; ventral surface concave, with a row of short setae. Carpus moderately short, two-thirds the length of merus; dorsal surface with a row of spinules increasing to spines distally and a row of moderately short setae; lateral and mesial faces unarmed; ventral surface smooth. Merus laterally compressed; dorsal margin with very few spinules and tufts of moderately short setae; lateral and mesial faces even and unarmed; ventral margin with a row of tufts of moderately short setae. Ischium moderately short, one-third the length of merus; unarmed except for tufts of short setae dorsally and ventrally. Coxa with few granules laterally and mesially, 1 or 2 tufts of setae present ventrally and dorsally.

Third pereiopod slightly longer than the second, reaching upto the tip of left cheliped. Dactylus moderately long, one and one-fourth the length of propodus; in lateral view turned ventrally; in dorsal view straight; ending in a short, corneous claw; dorsal and ventral margins with tufts of short setae; lateral and mesial faces with very few setae. Propodus moderately long, one and one-half the length of carpus; dorsal surface with a row of spinules and tufts of short setae; lateral and mesial faces unarmed; ventral surface concave with very few short setae. Carpus moderately short, as long as or four-fifths the merus; dorsal distal angle with a short spine; dorsal surface with a row of spinules and tufts of short setae; mesial and lateral faces unarmed; ventral surface with very few minute setae. Merus laterally compressed; dorsal and ventral margins with tufts of short setae; lateral and mesial faces even and unarmed. Ischium moderately long, one-half the length of merus; dorsal surface with a row of moderately short setae; ventral surface with 2 - 3 protuberances and tufts of short setae; mesial and lateral faces unarmed. Coxa with 2 - 3 tufts of short setae over protuberances.

Fourth pereiopod with well developed propodal rasp. Fifth pereiopod typical and minutely chelate. Sternite of third pereiopod with a prominent tooth proximally.

Pleopods of male 4 in number, unpaired, uniramous; with long, plumose setae. Female with first 3 unpaired, biramous, both rami well developed with dense tufts of long setae; 4th as in male. Uropods well developed, left one considerably larger than the right.

Telson asymmetrical, left lobe larger than the right; separated by a minute cleft; right terminal margin with a row of spinules and tufts of short setae or bristles; left terminal margin with 4 - 5 acute spines and row of spinules and tufts of bristles.

In female, left cheliped never exceeds pereiopods in distal extension. Third pereiopod exceeds left cheliped by one-half the length of dactylus. Carpus with a short ridge in the distal margin corresponding to the ridge on palm of males, in addition to the ridge on palm as in male.

**Collection localities:** Specimens were collected from Kali estuary and Baithkol area in Karwar, west coast of India.

**Materials examined:** About 100 specimens comprising both males and females were examined. The shield length ranged from 2.0 to 6.0 mm. Many of the females carried eggs.

The eggs were oval, dark brown to dirty green in colour immediately after oviposition, turning to pale and transparent when about to hatch. The egg size ranged from 0.30 to 0.34 x 0.23 to 0.25 mm.

**Habitat:** This species shared the habitat with *Diogenes avarus* and *D. maclaughlinae* at Baithkol, which has an admixture of sand and mud. In estuarine areas it was commonly found in association with *D. avarus* and *Clibanarius padavensis* occupying the lower part of the intertidal zone.

**Colour:** Shield, light gray or light green or pale. Ocular peduncle with a short longitudinal band of dark gray to dark brown colour. Antennular peduncle with a transverse gray band; flagellum without chromatophores. Antennal peduncle with few dark grey patches; flagellum with alternating dark and pale transverse bands between articles. Pereiopods with transverse dark grey bands.

**Remarks:** This species is named *Diogenes karwarensis*, after the type locality, Karwar, from where the specimens were discovered.

TABLE 1

| Character | *Diogenes avarus* Heller | *Diogenes karwarensis* sp.nov. |
|---|---|---|
| Ocular peduncle | 2/3 to 3/4 length of shield. | 1/2 to 2/3 length ofshield. |
| Antennular Peduncle | exceeds ocular peduncle by 1/3 to 2/5 length of ultimate segment. | exceeds ocular peduncle by 1/2 to 2/3 length of ultimate segment. |
| Left cheliped: Palm | shorter than carpus; dorsal surface granulose. | longer than carpus; dorsal surface spinulose. |
| Carpus | longest of all segments; ventral distal margin unarmed. | moderately short,ventral distal margin with a row of short spines. |
| Merus | ventral distal margin unarmed. | ventral distal margin with 3 - 4 long, conical, acute spines. |

## DISCUSSION

The species closely resembles *Diogenes avarus* Heller in having similar habitat preference, general size and shell selection. Some of the salient features by which these two species could be distinguished are given in Table 1.

ACKNOWLEDGEMENTS

We are grateful to Dr. P.A McLaughlin, Dr. Janet Haig and Dr. K.N. Sankolli for their valuable suggestions. Also, thanks are due to the authorities of Karnatak University for providing laboratory facilities.

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# A NEW SPECIES OF THE GENUS *EUPHILOSCIA* PACKARD (CRUSTACEA: ISOPODA: ONISCOIDEA) FROM WALTAIR, INDIA[1]

C. JALAJA KUMARI, K. HANUMANTHA RAO AND K. SHYAMASUNDARI[2]

(*With eleven text-figures*)

A new oniscoid isopod *Euphiloscia rishikondensis* belonging to family Ligiidae is described. Thirty male specimens were collected under rocks near the shore at Rishikonda, Waltair. *Euphiloscia rishikondensis* sp. nov. is compared with *E. elrodii* Packard, 1873.

In the course of the study of the systematics of isopods (1978-1981), a number of new species belonging to the genus *Euphiloscia* Packard (1873) were collected from Waltair coast.

Isopods of the genus *Euphiloscia* have not been reported from India so far. Significant contributions to the knowledge of Indian oniscoid isopods are those of Collinge (1914), Barnard (1936), Joshi and Bal (1959) and Ramakrishna (1971). The genus *Euphiloscia* is so far represented by only one species, namely *Euphiloscia elrodii* (Packard 1873). The present species is described here as a new species.

**Euphiloscia rishikondensis** sp. nov.

Male: Length 7 mm; breadth 3 mm.

Colour: Brown body with dark spots on the mid-dorsal portion.

Body oblong-oval, somewhat longer and slender, attains greatest breadth at pereonite 5, dorsal surface slightly convex, studded with granules in the centre. A large number of tubercles arranged in two rows on each side of pereon. Cephalon distinctly separated from pereonite 1; twice as broad as long. Dorsal surface of cephalon covered with numerous large tubercles; frontal margin nearly truncate and not produced into a lobe. Antero-lateral angles of cephalon rounded and not produced into lobes. Eyes large, oval and located at antero-lateral angles of cephalon.

Antennule reduced in size, triarticulate, with broad basal article, article 2 short and terminal article longer than basal article.

Antenna very much longer, slender, almost reaches the end of pereonite 3. Antenna with 5 peduncular articles, article 1 short, article 2, 3 subequal, article 4, roughly 1 1/2 times longer than article 3, article 5 twice as long as article 4. Antennal flagellum 15-articulate; all articles covered with strong setae, terminal article provided with a pointed bristle.

Maxillule with 12 stout recurved spines on

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[1] Accepted April 1987.

[2] Department of Zoology, Andhra University, Waltair 530003 (India).

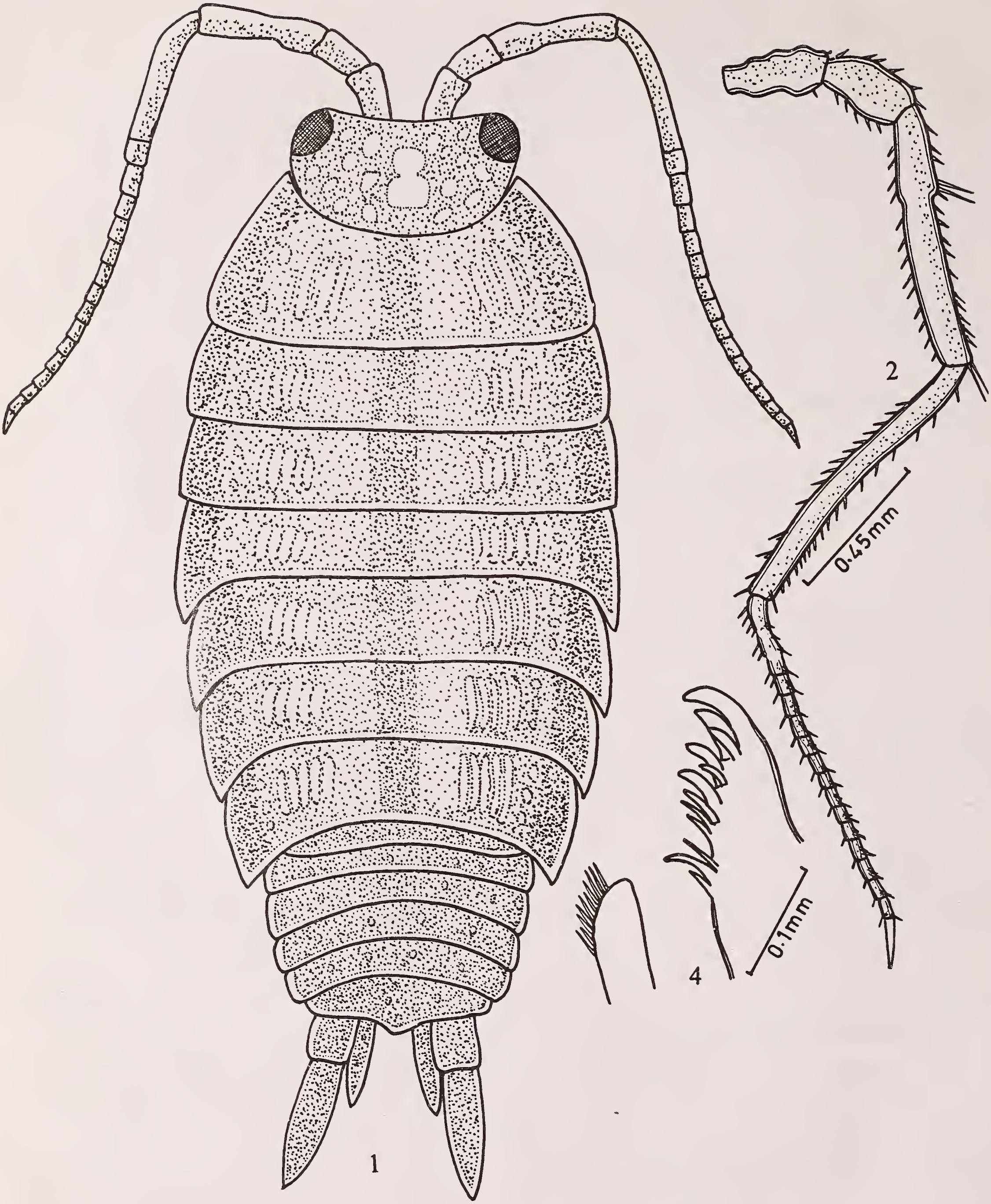
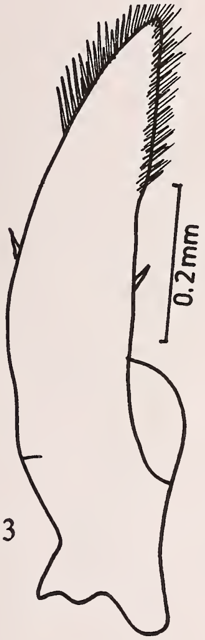

1
2
0.45mm
4
0.1mm

Fig. 1. *Euphiloscia rishikondensis* sp. nov.;
Fig. 2. Antennule; Fig. 4. Maxillule.

exopod; as series of setae on endopod. Maxilla uni-lobate, terminal part heavily setose. Mandible with 2-cuspate incisor process, followed by six penicils arise from the lower margin. Maxilliped with outer palp terminates into 3 setae; inner palp broad, apically trilobed; anterior margin of maxilliped covered with short setae.



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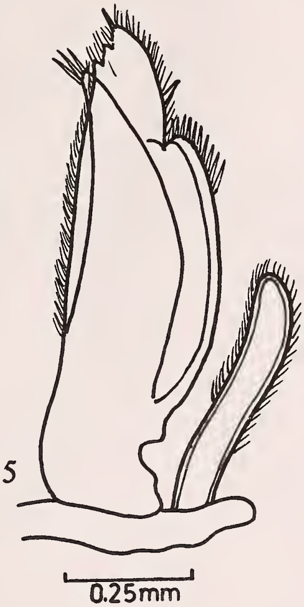

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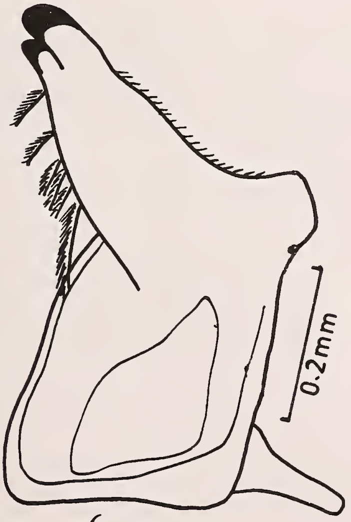


6

*Euphiloscia rishikondensis* sp. nov.

Fig. 3. Maxilla; Fig. 5. Maxilliped; Fig. 6. Mandible.

Pereonites 2-6 subequal, pereonite 1 longer than other pereonites. Antero-lateral angles of pereonite 1 surround the base of cephalon. Coxal plates not separated from pereonites. Pereonite 7 extends up to pleonite 2.

Pereopods 1-7 gradually increase in length posteriorly, long and stout, all markedly setose. Anterior pereopods prehensile and densely covered with setae. Posterior pereopods comparatively long and slender. First 5 articles of all pereopods covered with thick short hairs.

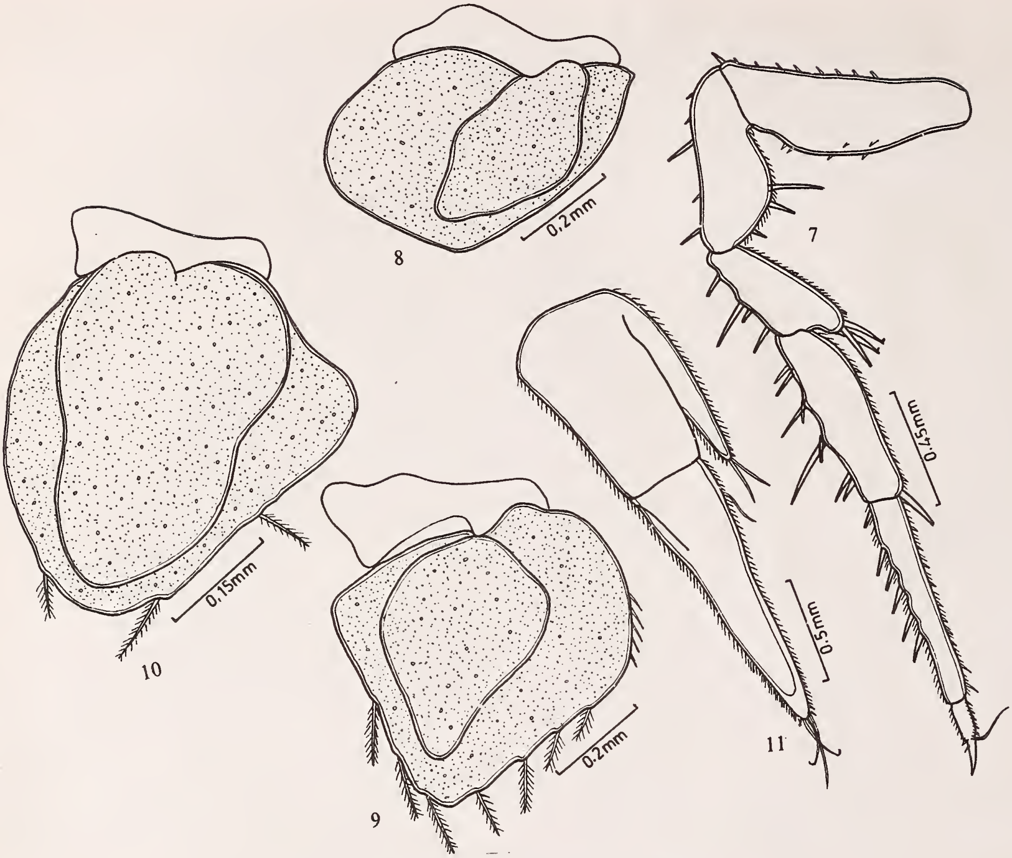
Pleon much narrower and rounded not macronate, pleonites 1-5 distinct, pleonites 2-5 subequal except pleonite 1. Side plates of all pleonites rather smooth and not projecting posteriorly. Pleopod 1 small, both exopod and endopod devoid of setae. Appendix masculina of pleopod 2 arises from basis, exceeds with exo- and endopods and terminally blunt. Exopod of pleopod 2 covered with 7 plumose setae and 6 simple setae. Pleopods 3, 4 almost similar, exopod of both pleopods covered with 3 plumose setae. Endopods of all pleopods devoid of setae. All pleopods provided with air-cavities.

Telson sub-triangular, posteriorly terminates into a blunt and nearly round tip; uropod longer and slender, articulates to the tip of telson. Uropodal peduncle stout and broad. Endopod of uropod short and narrow, just reaches the basal part of exopod and terminates into 2 long setae. Exopod of uropod long, broad at the base and terminally provided with 3 long curved setae. Uropods also covered with short, thick hairs.

**Material Studied:** Thirty male specimens were collected under rocks near the shore at Rishikonda, Waltair. Holotype male 1 and paratypes male 4 are lodged in the Department of Zoology, Andhra University, Waltair. They will be deposited in the collections of the Zoological Survey of India, Calcutta.

## DISCUSSION

The genus *Euphiloscia* differs from the genus *Philoscia* in having fifteen articulated flagellae of the antenna. The second and third



*Euphiloscia rishikondensis* sp. nov.

Fig. 7. Pereopod 7; Fig. 8. Pleopod 1; Fig. 9. Pleopod 3; Fig. 10. Pleopod 5; Fig. 11. Uropod.

joints are rather short, antenna very much longer. The abdomen is much longer and wider in proportion to the rest of the body. Uropods are much larger and slender than in *Philoscia*. The body colour of the species is brown with dark spots on the mid- dorsal portions. *Euphiloscia rishikondensis* sp. nov. resembles *Euphiloscia elrodii* in body colour, but differs in the shape of cephalon, pereon and pleon and structure of appendages.

The species name is derived from the collection locality Rishikonda.

## ACKNOWLEDGEMENTS

One of us (CJK) is grateful to the Council of Scientific and Industrial Research for financial assistance. We are thankful to authorities of Andhra University for providing facilities.

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# A NEW SPECIES OF *THERIDION* WALCKENAER (ARANEAE : THERIDIIDAE) FROM INDIA[1]

KANCHAN MONGA[2] AND J.P. SINGH[3]

(*With three text-figures*)

**Theridion** Walckenaer, 1805.

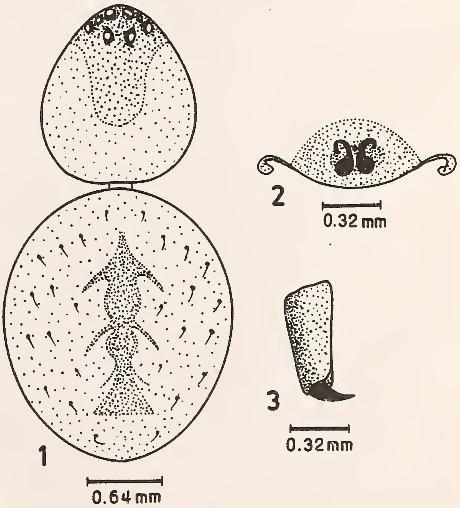
*Theridion* Walckenaer, 1805. Tabl. Aran.: 1-88.

Anterior median eyes equal to or smaller than posterior medians which are usually a little wider apart, laterals contiguous. Chelicerae usually weak. Sternum rounded behind, projecting between coxae IV. Legs long and thin; tarsus IV with a row of 6-10 serrated bristles. Abdomen globular in shape, usually bearing a distinct pattern.

**Theridion sadani** sp nov. (Figs. 1-3)

Female cephalothorax : Carapace : length 1.68 mm; maximum breadth 1.44 mm; yellow with cephalic region marked from thoracic region by light cephalic groove; thoracic region marked with transverse thoracic fovea. Eyes eight, encircled by black rims; anterior medians darker than the rest of the eyes and equal to posterior medians; arranged in two rows; anterior row recurved while posterior row procurved. Diameter of eyes (mm): A.M. = 0.12; A.L. = 0.11; P.M. = 0.12 and P.L. = 0.09. Mutual distances between the eyes (mm): A.M.-A.M. = 0.16; A.M.-A.L. = 0.15; A.M.-P.M. = 0.17; A.M.-P.L. = 0.20; P.M.-P.M. = 0.20; P.M.-P.L. = 0.19; P.L.-P.L. = 0.49 and A.L.-A.L. = 0.47. Width of clypeus: 0.22 mm, wide, concave and yellow in colour. Chelicerae: small, yellow without any teeth on any margin. Maxillae: yellow, broader at base, narrower towards anterior end, a few hairs present at anterior margin. Labium : yellow, not reboardered. Sternum : yellow, longer than broad, posterior end narrowed and extending between coxae IV. Legs : yellow, long and thin, tarsus IV with a row of 6 spines on ventral side, tarsi with three claws and without any claw tufts. Leg I thrice the length of body. All legs provided with papillae. Length of legs (mm):

| Leg | Coxa | Trochanter | Femur | Patella | Tibia | Metatarsus | Tarsus | Total |
|---|---|---|---|---|---|---|---|---|
| I | 0.50 | 0.30 | 3.40 | 0.73 | 3.00 | 3.00 | 1.03 | 11.96 |
| II | 0.33 | 0.27 | 2.27 | 0.67 | 1.60 | 1.66 | 0.77 | 7.57 |
| III | 0.37 | 0.20 | 1.37 | 0.59 | 0.87 | 1.07 | 0.53 | 5.00 |
| IV | 0.40 | 0.33 | 2.33 | 0.63 | 1.63 | 1.93 | 0.77 | 8.02 |
| Pedipalp | — | — | 0.43 | 0.10 | 0.27 | — | 0.50 | 1.30 |



Figs. 1-3. *Theridion sadani* sp. nov.
1. Dorsal view of female; 2. Epigynum; 3. Chelicera.

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[1] Accepted August 1988.

[2] Haryana Agricultural University, Hissar, Haryana (India).

[3] Department of Zoology, Punjabi University, Patiala, Punjab (India).

*Abdomen:* Length 2.40 mm; maximum breadth 2.20 mm; oval but rounded behind. Dorsum grey, mottled with white that forms a pattern with grey veins in the centre. Venter grey with white markings, covered by papillae all over. Spinnerets compact. Epigynum as in Fig. 3.

*Total length:* Female 4.08 mm.

**Holotype** Female, in spirit, INDIA: Jammu and Kashmir; Shalimar Gardens, Srinagar, 25.v.1977, G.L. Sadana.

This species slightly resembles *Theridion tikaderi* Patel but can be separated from it as follows (i) Absence of U-shaped mark on cephalothorax, (ii) The abdomen is oval, grey, mottled with white and forming a pattern with grey veins in the centre, while in *T. tikaderi*, abdomen is globular and dorsal and ventral sides are with chalky white and chocolate patches, (iii) Epigynum is also structurally different.

## ACKNOWLEDGEMENTS

We thank Dr. G. L. Sadana, Department of Zoology, Punjab Agricultural University, Ludhiana for providing the collection and Professor and Head, Department of Zoology, Punjabi University, Patiala for providing the necessary laboratory facilities.

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# A NEW *SONERILA* ROXB. (MELASTOMATACEAE) FROM SOUTHERN INDIA[1]

R. GOPALAN AND A.N. HENRY[2]

(*With nine text-figures*)

**Sonerila Kanniyakumariana** sp. nov.

Herbae succulentae, 50-65 cm altae; caules subrosei, erecti (nodi inferi rare decumbenti et radicanti), minute alati, glabri. Folia 0.5 - 4.2 x 0.5 - 2.5 cm, superi subsessiles, inferi breviter petiolati, ovati ad deltoidi, succulenti, glabri, ad apicem acuti, ad basim cordati vel subcordati, 3-5-nervati; margines serrati, hyalini. Racemi terminales, scropioidei, floribus 3-5, flori subrosei; pedunculi 5-7 mm longi, glabri. Calycis tubi 5-8 mm longi, infundibuliformes, glabri; calycis lobi 3, utrumque *c*. 3 x 2 mm, triangulare. Petala 3, utrumque usque ad 1.5 cm latum, ovato - orbiculare, apiculatum. Stamina 3; filamenta *c*. 5 mm longa, crassa, glabra; antherae lanceatae, usque ad 6 x 2 mm, rostratae. Stylus 10-12 mm longus; stigma capitellatum. Capsulae 8-10 x 4-5 mm, infundibuliformes, glabrae; semina *c*. 1 mm longa, tuberculata.

Holotypus (Gopalan 77180, CAL) et isotypi (Gopalan 77180, MH-num. acc. no. 139866 - 139874) in Upper Kodayar in ditione Kanniyakumari in statu Tamilnadensi, India, die 20.3.1984 lecti. Paratypi (Henry 77001, MH-num. acc. no. 139875 - 139883) in Upper Kodayar, versus viam ad Muthukuzhivayal, die 16.2.1983 lecti.

Succulent herbs 50-65 cm tall; stems pinkish, erect (rarely decumbent and rooting at lower nodes), minutely winged, glabrous. Leaves 0.5 - 4.2 x 0.5 - 2.5 cm, upper subsessile, lower shortly petioled, ovate to deltoid, fleshy, glabrous, acute at apex, cordate or subcordate at base, 3-5 nerved; margins serrate, hyaline. Flowers pinkish, 3-5 in terminal scorpioid racemes; peduncles 5-7 mm long, glabrous. Calyx tube 5-8 mm long, funnel- shaped, glabrous; calyx lobes 3, each *c*. 3 x 2 mm, triangular. Petals 3, each up to 1.5 cm across, ovate-orbicular, apiculate. Stamens 3; filaments *c*. 5 mm long, thick, glabrous; anthers up to 6 x 2 mm, lanceate, beaked. Style 10 - 12 mm long; stigma capitellate. Capsules 8 - 10 x 4 - 5 mm, funnel-shaped, glabrous; seeds *c*. 1 mm long, tuberculate. (Figs. 1-9).

Holotype (Gopalan 77180, CAL) and isotypes (Gopalan 77180, MH-acc. no. 139866 - 139874) were collected at Upper Kodayar in Kanniyakumari District, Tamilnadu on

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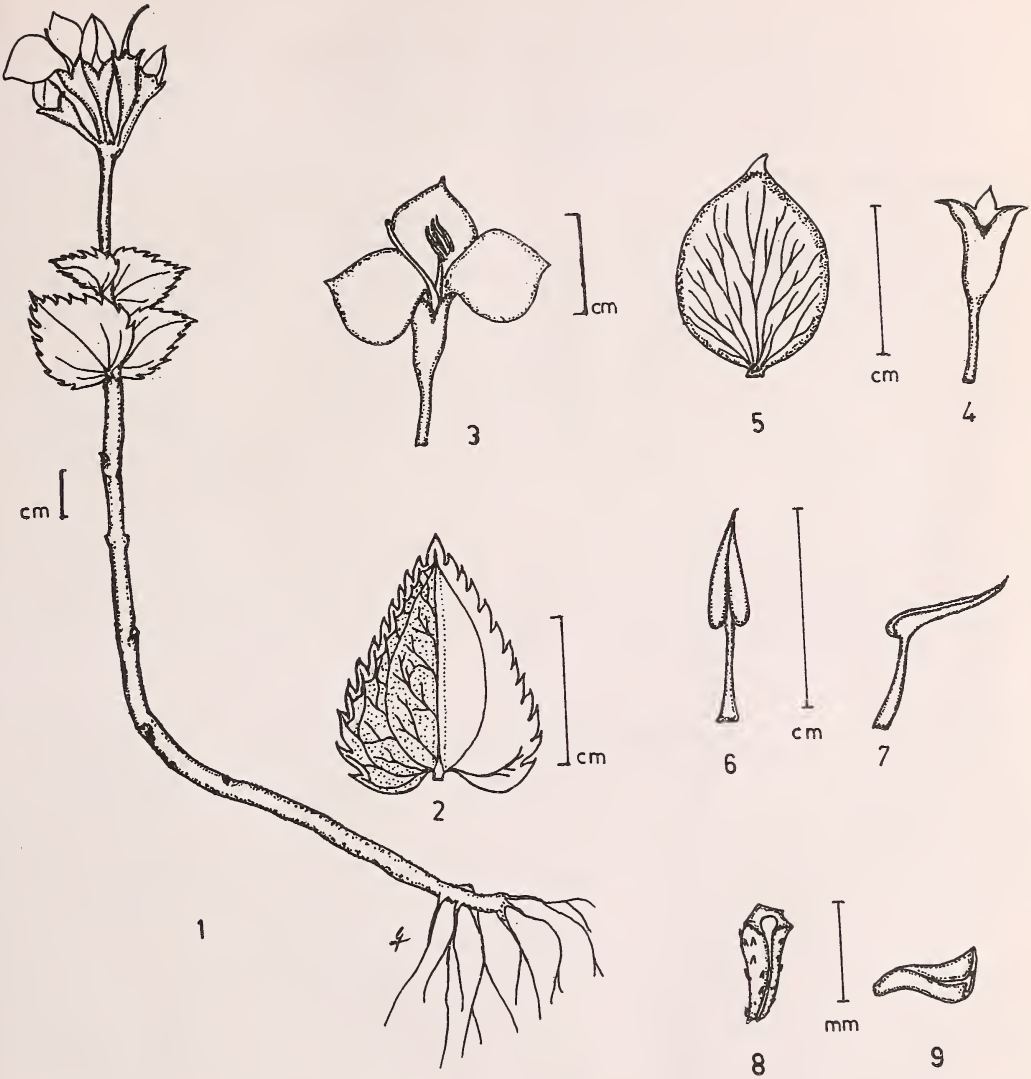
[1] Accepted November 1987.

[2] Botanical Survey of India, Coimbatore (India).



Figs. 1–9. *Sonerila kanniyakumariana* sp. nov.
1. Portion of plant; 2. Leaf; 3. Flower; 4. Calyx; 5. Petal; 6 & 7. Stamen (2 views); 8 & 9. Seed (2 views).

20.3.1984. Paratypes (Henry 77001, MH-acc. No. 139875 - 139883) were collected from Upper Kodayar on the way to Muthukuzhivayal on 16.2.1983.

This species is perhaps allied to the Sri Lankan *Sonerila robusta* Arn. but differs in: glabrous stem; leaves glabrous, serrate, somewhat crowded towards the apices of stems; and capsules funnel-shaped, glabrous.

Occurs on exposed rocky slopes and road-cuttings in evergreen forests. Rare.

We are thankful to Dr. N.P Balakrishnan, Scientist 'SE' for encouragement, and Dr. V.J. Nair, Scientist 'B' for the Latin translation of the description.

# *UTRICULARIA MALABARICA* SP. NOV. (LENTIBULARIACEAE): A TERRESTRIAL BLADDERWORT FROM SOUTHERN INDIA[1]

M.K. Janarthanam and A.N. Henry[2]

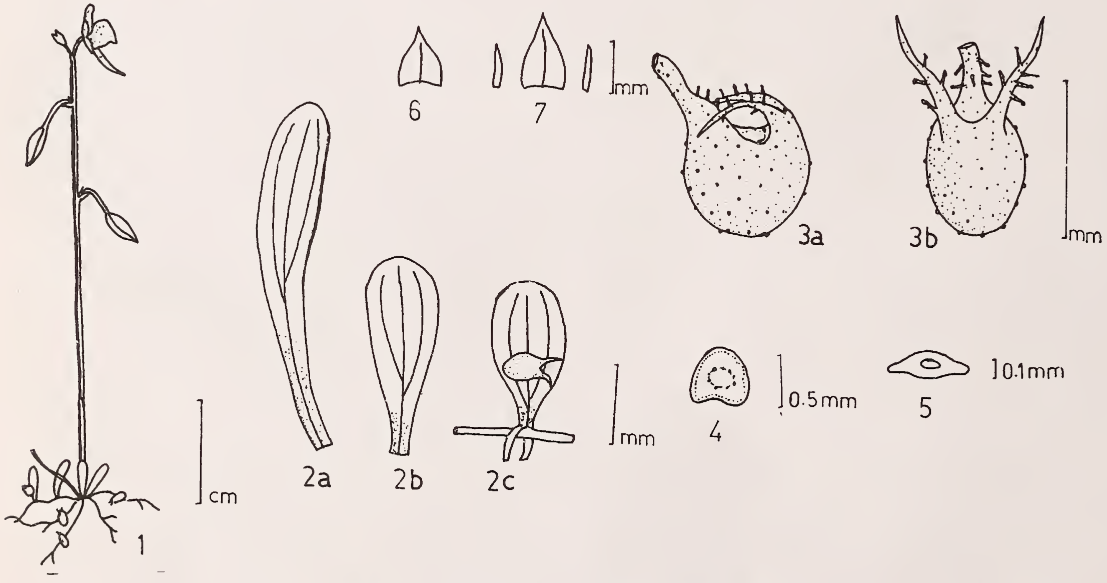
(*With sixteen text-figures*)

**Utricularia malabarica** sp. nov.
(Figs. 1 - 16)

*U. lazulina* P. Taylor affinis, sed plantis parvissimis; calyce lobis equalibus et papillosis; corolla margine labii superi glabra; labio infero stigmatis piloso; pedicello fructificanti recurvato; semine ovoideo et testa laevigata differt.

Holotypus (M.K. Janarthanam 82924, CAL) et isotypi (M.K. Janarthanam 82924, MH - num. acc. no. 139935 - 139938) in Mulleriya in ditione Kasaragod in statu keralensi India die 21.8.1985 lecti.

Small herbs. Rhizoids mostly absent, if present up to 1 cm long, *c* 0.2 mm thick at base, terete, glandular; branches few, up to 0.8 mm long, papillose. Stolons up to 2 cm long, *c* 0.2 mm thick, capillary, terete, profusely branched; internodes *c* 2 mm long. Leaves up to 4 x 1.5 mm, solitary at base of scape and at each stolon node; petioles attenuate; lamina obovate, 3-nerved, rounded at apex. Traps up to 1.5 mm across, few, on stolons and leaves, globose; stalk short, often covered with glandular hairs; mouth basal; appendages 2, subulate, simple, glandular. Inflorescence 2-6.5 cm long, erect; peduncle *c* 0:6 mm thick, glabrous, angular, grooved on one side. Scales *c* 1.1 x 0.9 mm, 1- few, basifixed, ovate-deltoid. Bracts *c* 1.5 x 0.9 mm, ovate-deltoid, acuminate; bracteoles subulate, shorter than bract. Flowers 1-4; pedicels 3-4 mm long, winged, erect in anthesis and recurved in fruit. Calyx lobes



Figs. 1 – 7 *Utricularia malabarica* sp. nov.
1. Plant; 2a – 2c. Leaves; 3a. Trap – lateral view; 3b. Trap – front view; 4. T.S. of peduncle; 5. T.S. of pedicel; 6. Scale; 7. Bract and bracteoles;

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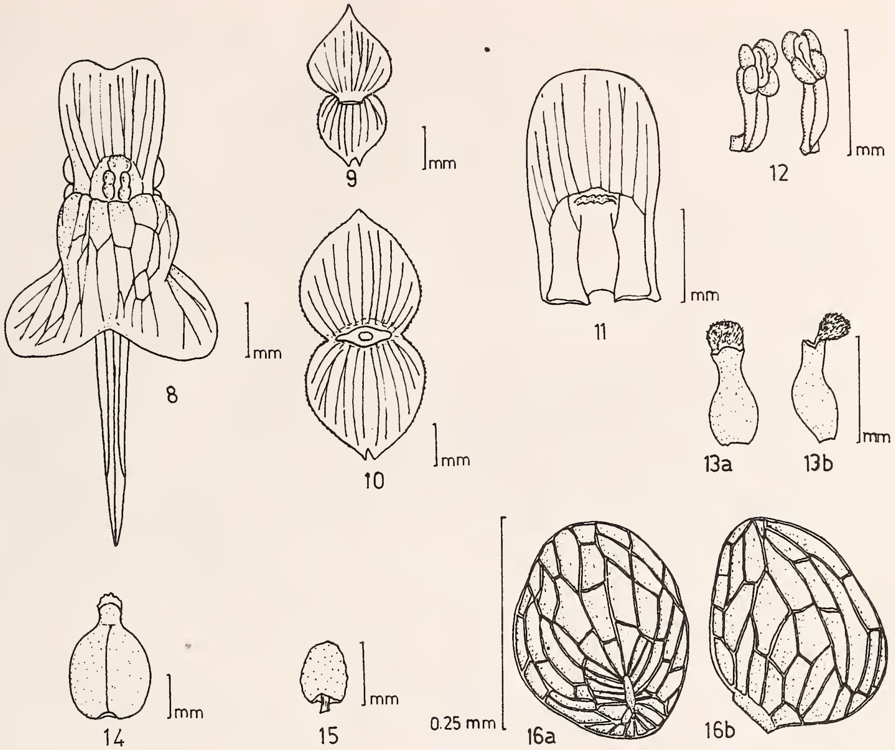
[1] Accepted October 1987.

[2] Botanical Survey of India, Coimbatore (India).



Figs. 8 – 16 *Utricularia malabarica* sp. nov.
8. Flower (front view); 9. Flowering calyx; 10. Fruiting calyx;
11. Corolla Upper lip; 12. Stamens; 13a. Pistil – adaxial view;
13b. Pistil – lateral view; 14. Capsule; 15. Placentum; 16a. Seed – front view; 16b. Seed – lateral view.

more or less equal, *c* 2 x 2 mm in anthesis, *c* 3 x 3 mm in fruit, ovate, 10-12 nerved, outer surface and margin paillose, upper lobe acuminate, lower lobe bidentate. Corolla 7-8 mm long; upper lip *c* 2.5 x 1.5 mm, oblong, white with blue tinge, truncate or emarginate at apex; lower lip *c* 4 x 5 mm, more or less orbicular, blue; base prominently bigibbous, white with blue reticulations, apex emarginate; palate hairy, spur *c*. 4.5 mm long, slender, blue to bluish white, acute and yellow at apex, Stamens *c*. 1 mm long; filaments strap-shaped; antherthecae distinct. Pistil *c*. 1 mm long; ovary ovoid; style short; stigma bilabiate, lower lip oblong and hairy, upper lip short and semiorbicular. Capsules *c* 2.8 x 1.8 mm, ovoid-subglobose, uniformly membranous, dehiscing by a dorsal and a ventral longitudinal slit; placentum *c* 1 mm long, ovoid, stalked. Seeds *c* 0.25 mm long, ovoid; hilum prominent, subterminal; testa reticulate, smooth, cells more or less elongate.

*Utricularia malabarica* is allied to *U. lazulina* P. Taylor, but differs in: plants much smaller; calyx lobes equal and papillose; margin of upper corolla lip glabrous; lower lip of stigma hairy; fruiting pedicel recurved; seeds ovoid and testa smooth.

Holotype M.K. Janarthanam 82924 (CAL) and isotypes M.K. Janarthanam 82924 (MH acc. no. 139935 - 139938) were collected from Mulleriya, Kasaragod District, Kerala (Old Malabar region), Southern India on 21.8.1985.

An annual occurs on wet laterite rocks, in association with *Eriocaulon* sp. and grasses; flowering and fruiting in August.

Thanks to Dr. N.P. Balakrishnan, Scientist 'D', Botanical Survey of India, Southern Circle for providing facilities and for encouragement, to Dr. V.J. Nair, Scientist 'B', Botanical Survey of India, Southern Circle for the Latin translation of the diagnosis, and to the Director, Botanical Survey of India, Calcutta, for sanctioning research fellowship to one of us (MKJ).

# A NEW SPECIES OF *STIXIS* LOUR. (CAPPARACEAE) FROM MANIPUR[1]

D.B. DEB AND R.C. ROUT[2]

(*With a text-figure*)

A new species *Stixis manipurensis* (Capparaceae) recently collected from Manipur State is described and illustrated.

## INTRODUCTION

Deb explored the flora of Manipur State during 1951-1955 (vide *Bull. Bot. Surv. India* 3: 115-133 & 253-350, 1963). His manuscript on Pteridophytes was unfortunately lost and could not be published. Subsequently he conducted field studies for brief periods in 1978, 1982 and recently in July 1987 in different parts of the state with a view to note the extent of changes in the vegetation during the last three decades or so, and for further addition to the Flora.

In July 1987, he went up to the Burma border and saw frequently along the National High way from Tengnopoul to Morey a tall climber mostly in fruit. He took it for *Stixis suaveolens*, but on examination in herb. CAL it turned out to be a new species.

The genus *Stixis* Lour. (Capparaceae) known in the Indian Floras under the name *Roydsia* Roxb. has been recently studied by Jacob (vide Blumea 12:5-12, 1963) treating *S. suaveolens* (Roxb.) Pierre as the type. The genus is represented by seven species distributed in Nepal, Bhutan, Eastern India, South China, Burma, Vietnam, Indochina, Hainan and Western Malaysia.

**Stixis manipurensis** sp. nov. (Fig. 1)

Differt a *S. suaveolens* foliis parvioribus et angustioribus, sepalis ovatis, androgynophoris gynophorisque brevissimum inter alia; a *S. scandens* bracteis ellipticis, sepalis ovatis, staminibus numero majoribus, gynophoris brevioribus, glabris inter alia; a *S. ovata* bracteis brevioribus, sepalis ovatis, androgynophoris gynophorisque bravioribus, ovariis stellato-pilosis, stylis brevioribus, glabris inter alia.

Differs from *S. suaveolens* in smaller and narrower leaves, ovate sepals and much shorter androgynophore and gynophore, amongst others; from *S. scandens* in elliptic bracts, ovate sepals, larger number of stamens and shorter glabrous gynophore; from *S. ovata* in smaller bracts, ovate sepals, shorter androgynophore and gynophore, larger number of stamens, stellately hairy ovary and shorter glabrous style.

Climbing shrubs *c*. 15-20 m in height, profusely branching above, unarmed; stem terete, lenticellate. *Leaves* simple, alternate, congested on branchlets, 7.5-16.0 x 2.5-5.0 cm, elliptic-oblong, coriaceous, acute or shortly acuminate at apex, acute or obtuse at base, entire, glabrous, unicostate, reticulate; lamina profusely pustulate with bacterial nodules; lateral nerves 7-10 on either side, alternate or subopposite, arching obliquely towards the margin; midrib slightly sunken above, prominent, sometimes pustulate beneath. *Flowers* in axillary panicle or raceme, yellowish, sweetly scented, minutely pubescent; bracts caducous, *c*. 2.0 x 1.0 mm, elliptic, acute at apex, pubescent; pedicel 1.0-1.5 mm long, stout. Floral buds 4.0-4.5 x 3.0-4.0 mm, obovoid or spherical. *Sepals* 6 in two whorls, spreading, not reflexed at anthesis, imbricate, 3.0-3.5 x 2.5 mm, ovate, acute at apex, fulvous tomentose on both sides. *Petals* absent. Androgynohore *c*. 0.2 mm long, glabrous. *Stamens* more than 40; filaments *c*. 2 mm long, glabrous; gynophore *c*. 0.2 mm long, glabrous. *Ovary c*. 1.2 x 1.0 mm, ovoid, stellately hairy, 3 loculed, each bearing 2 ovules on axillary placenta; style *c*. 0.5 mm long; stigma 3 lobed. *Fruit* 2.5-3.1 x 1.2-1.6 cm ellipsoid, 3 angled; pericarp 2.5 mm thick, distinguished into thick epicarp, spongy meso-

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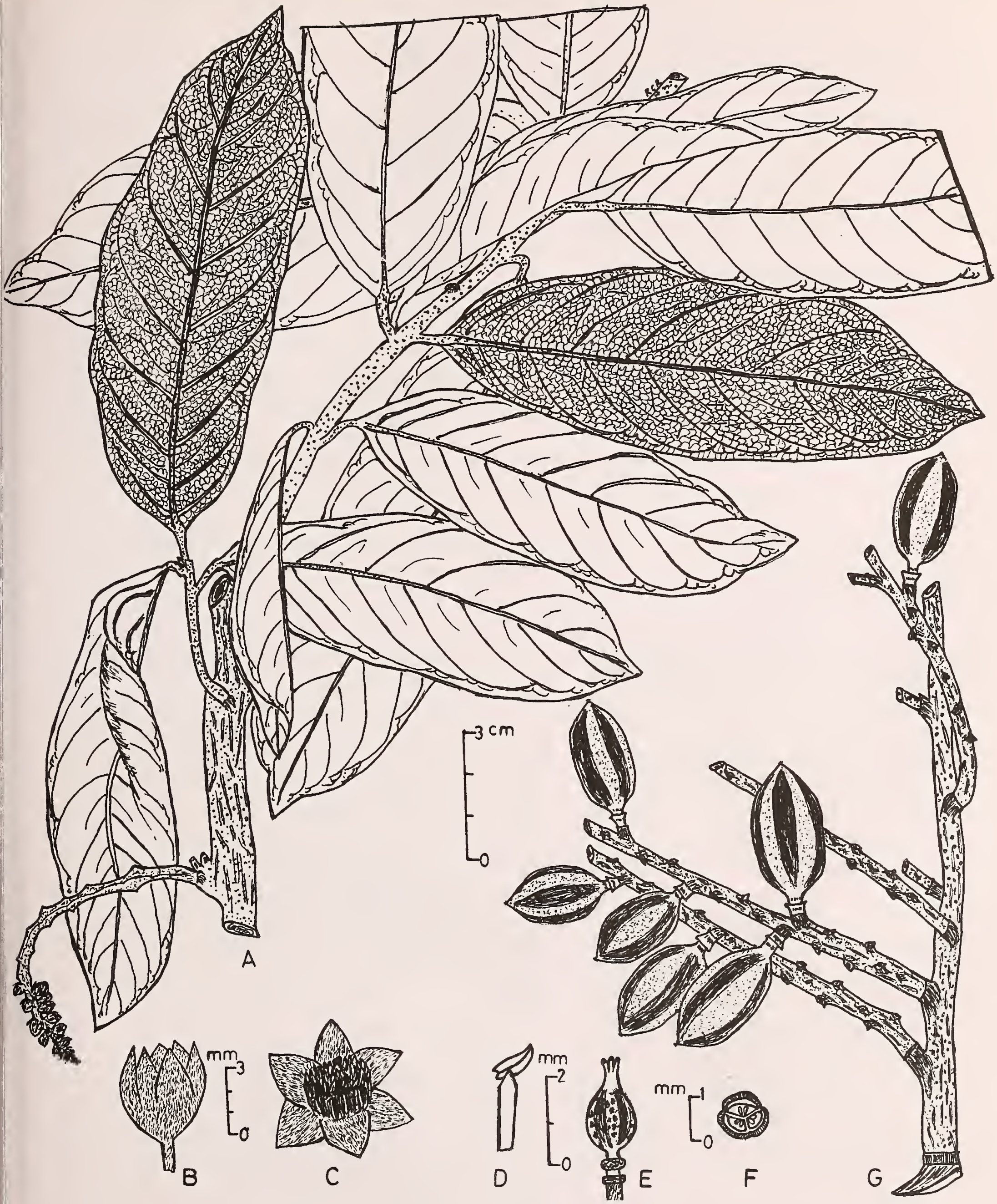
[1] Accepted December 1987.

[2] Botanical Survey of India, Howrah (India).


A
3 cm
0
mm
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B
C
mm
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Fig. 1. *Stixis manipurensis* sp.nov.

A. Habit; B. Flower bud; C. Flower opened; D. Stamen; E. Gynoecium with androgynophore and gynophore. F. Placentation; G. Fruiting panicle.

carp and thin endocarp. *Seeds* one, large, embedded in the pulp with a thin testa; cotyledons large, unequal, one enclosing the other.

*Flowering:* April-August; *Fruiting:* July - ?

*Distribution:* Tengnopoul to Morey, frequently occurring along the trunk road, on forest slopes.

*Type:* Manipur State, Tengnopoul, 1500 m, 30.7.87, *D.B. Deb* 3549A holotype & B a fruiting panicle (detached from the type) deposited at CAL.

*Note:* Sundara Raghavan, R. has just published a new species from Burma (vide *Bull. Bot. Sur. Ind. 28*: 191, 1988), which is very different from the one described here.

## ACKNOWLEDGEMENTS

Thanks are due to Shri Sh. Tomchou Singh, I.F.S., Additional Chief Conservator of Forests, Govt. of Manipur for providing transport and other facilities to conduct the field study, and to Shri Gopal Singh, I.F.S., Assistant Conservator for assistance during the tour.

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# NEW TAXA OF DESMIDS FROM UTTARA KANNADA DISTRICT KARNATAKA STATE (INDIA)[1]

G. R. HEGDE [2] AND S. W. ISAACS[3]

(*With four text-figures*)

During 1978 in all 72 collections from freshwater permanent ponds and lakes of Uttarakannada District of Karnataka State were made. These samples contained four new taxa of Desmids which are described.

During an extensive survey of freshwater algae of Uttar Kannada District of Karnataka State, we came across four new taxa of Desmids. A total of 72 collections were made during 1978 from permanent ponds and lakes. All these samples are deposited in Department of Botany, Kittel Collge, Dharwad under the Accession No(s). : NK-1 to NK - 72.

**Cosmarium cuneatum** Josh. var. **truncatum** var. nov. (Fig. 1).

Simile typo descripto a Forster 1972 (Tab. 18, Fig. 14, p. 549) e quo differt sinu inaperto in latere interiore et leviter aperto ad latus exterius; margines laterales magis convergentes qui apicem truncatum formant; paries punctatus solum ad regionem verrucarum medianarum. Cellulis a vertice visis ellipticis, latera rectiora convergentia ut forment polos paene truncatos parietibus crassis. Cellulae 43-44 microns longae, 43-44 microns latae; Isthmus 7-8 microns latus, 25-26 microns crassus.

*Iconotypus* : Fig. 1.

*Distributio* : NK-70, Kumta.

Similar to the type described by Forster 1972 (pl.18, fig. 14, p. 549). Differs in having the sinus closed on inner side and slightly open towards exterior; lateral margins more convergent and form a truncate apex; Wall punctate only at the region of median verrucae. Vertical view elliptic, sides more straight, converging to form almost truncate and thick walled poles. Cells 43-44 microns long; 43-44 microns broad; Isthmus 7-8 microns broad; 25-26 microns thick.

*Iconotype* : Fig. 1.

*Distribution* : NK-70; Kumta.

**Cosmarium kanadense** sp. nov. (Fig. 2)

Cellulae leviter longiores quam latiores; semicellulae late semicirculares; margines laterales undulati et dentati; anguli basales spinis acutis crassisque praediti; sinus undulatus et latior prope partem exteriorem. Semicellulae annulum spinarum 12 subapicalium longiorum, quae acutae crassaeque sunt, ferentes; ornamentum centrale granula quattuor habet, tria in

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[3] Department of Botany, Kittel College, Dharwad - 580001 (India).

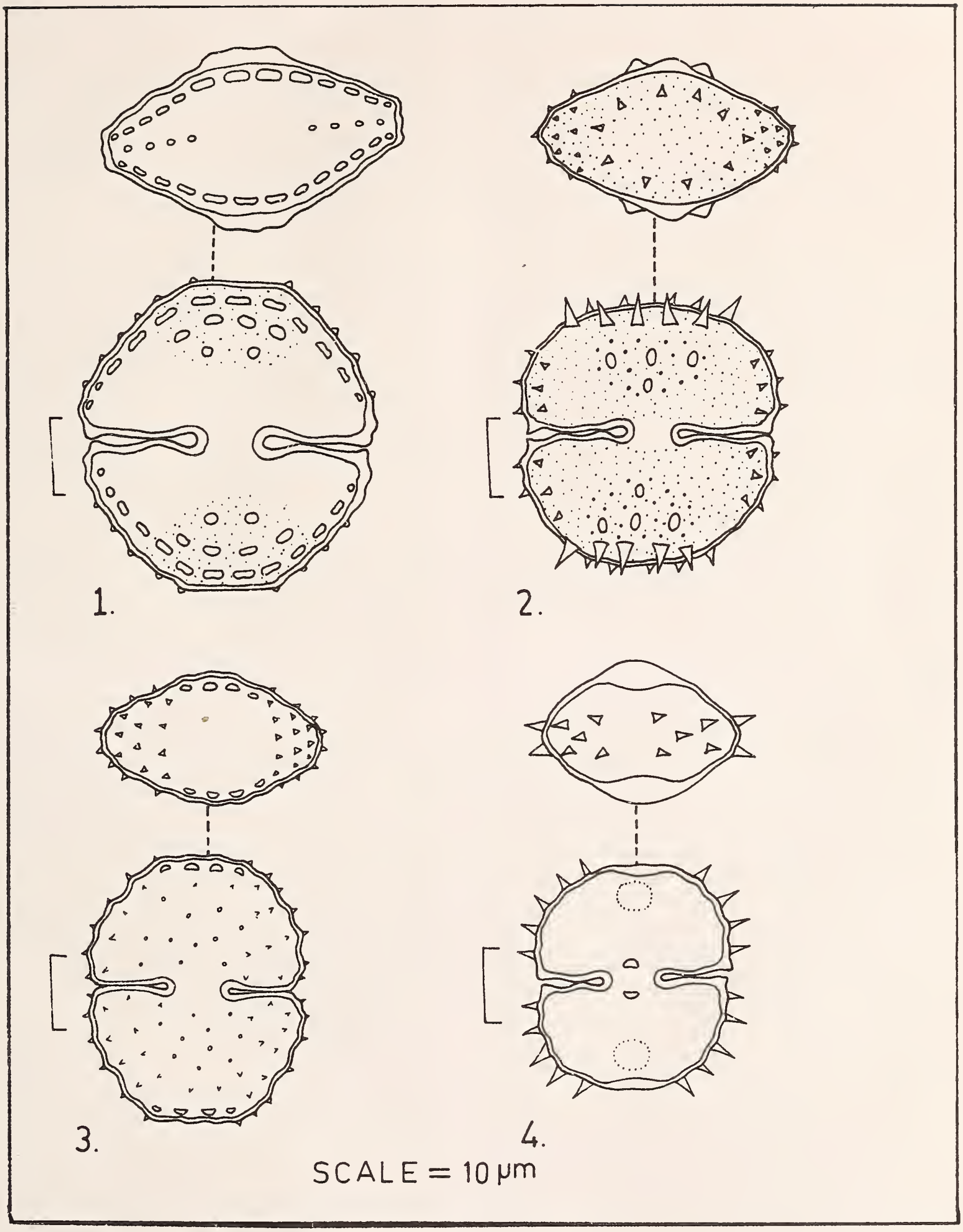

Fig. 1. *Cosmarium cuneatum* Josh. var. *truncatum* var. nov.
Fig. 2. *Cosmarium kanadense* sp nov.
Fig. 3. *Cosmarium vitiosum* Scott *et* Gronbl. var. *orientale* Scott *et* Prescott fa. *egranulatum* fa. nov.
Fig. 4. *Xanthidium tirthalliensis* Bharati *et* Hegde fa. *incrassatum* fa. nov.

serie una deposita et unum infra depositum, circumcincta a poris maioribus. Paries non valde punctatus. Cellulae visae a vertice ellipticae; poli late rotundati, undulati spinis minoribus praediti; latera granulis medianis praedita; spinae decem in annulo elliptico intramargi-

naliter depositae. Cellulae sine spinis 35-37 microns longae, cellulae spiniferae 38-40 microns longae et 32-36 microns latae; Isthmus 5-7 microns latus, 20-22 microns crassus.

*Iconotypus* : Fig. 2.

*Distributio* : NK-37.

Cells slightly longer than broad; semi-cells broadly semicircular; lateral margins undulate with pointed teeth; basal angles possess pointed stout spines; sinus undulate and more broad towards exterior. Semicells bear a ring of longer, pointed and stout 10 subapical spines; central ornamentation has four granules, 3 in a row and one below surrounded by bigger pores. Wall faintly punctate. Vertical view elliptical, poles broadly rounded, undulate and posses smaller spines; sides with median granules; intramarginally 10 spines are arranged in an elliptical ring. Cells without spines 35-37 microns long, with spines 38-40 microns long; with spines 32-36 microns broad; Isthmus 5-7 microns broad; 20-22 microns thick.

*Iconotype* : Fig. 2.

*Distribution* : NK-37.

**Cosmarium vitiosum** Scott *et* Gronbl. var. **orientale** Scott *et* Prescott fa. **egranulatum** fa. nov. (Fig. 3).

Similis typo forma (Scott *et* Prescott 1961; Tab. 31, figs. 1 & 2, p. 73), sed differt amplitudine minore (Cellulae typi 39-42 microns longae, 33-39 microns latae; Isthmus 10-12 microns latus, 20-23 microns crassus). Sunt verrucae subapicales quattuor quarum duae centrales comparate maiores sunt; differt a typo granulis facialibus absentibus; spinae in margine laterali comparate breviores sunt. Pars reliqua spinis brevibus obtecta. Cellulae 30-33 microns longae, 29-30 microns latae; Isthmus 6 microns longus, 17 microns crassus.

*Iconotypus* : Fig. 3.

*Distributio* : Nk-31, Banavasi (Sirsi).

Similar to the type (Scott and Prescott 1961; pl. 31, figs. 1 & 2, p. 73) in shape, differs by its smaller size (Type cells 39-42 microns long; 33-39 microns broad; Isthmus 10-12 microns broad; 20-23 microns thick). Of the four subapical verrucae, the central two are comparatively bigger; unlike the type the facial granules are absent; spines on lateral margins are comparatively shorter. Rest of the area covered with short spines. Cells 30-33 microns long; 29-30 microns broad; Isthmus 6 microns broad; 17 microns thick.

*Iconotype* : Fig. 3.

*Distribution* : NK-31, Banavasi (Sirsi).

**Xanthidium tirthalliensis** Bharati *et* Hegde fa. **incrassatum** fa. nov. (Fig. 4).

Planta similis typo (Bharati *et* Hegde 1982; Fig. 2, p. 4-5) amplitudine formaque, sed differt crassitudine subapicali luteola in quaque semicellula. Margo apicalis leviter truncatus parie incrassato interiore. Cellulae sine spinis 27-28 microns longae et 25-26 microns latae; cellulae spiniferae 30-33 microns longae et 29-30 microns latae; Isthmus 5 microns latus.

*Iconotypus* : Fig. 4.

*Distributio* : NK-35, Janamane (Sirsi).

A plant similar to the type (Bharati and Hegde 1982; Fig. 2, p. 4-5) in size and shape, differs by having subapical pale yellow coloured incrassation on each semicell. Apical margin slightly truncate with thickened inner wall. Cells without spines 27-28 microns long, with spines 30-33 microns long; Without spines 25-26 microns broad, with spines 29-30 microns broad; Isthmus 5 microns broad.

*Iconotype* : Fig. 4.

*Distribution* : NK-35, Janamane (Sirsi).

## ACKNOWLEDGEMENTS

We are thankful to Mrs. Angela Shipman for rendering the Latin diagnoses to the new taxa. One of the authors (SWI) is grateful to the Principal, Prof. S.J. Deodhar and the Management of Kittel College, Dharwad for the facilities and encouragement.

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# REVIEWS

## 1. NATURE CONSERVATION: THE ROLE OF REMNANTS OF NATIVE VEGETATION. Edited by D.A. Saunders, G.W. Arnold, A.A. Burbidge and A.J.M. Hopkins. pp. xiii + 410 (30 x 21 cm), with 26 colour plates and many illustrations. Chipping Norton, NSW, Australia, 1987. Surrey Beatty & Sons, Pty Ltd. Price not mentioned.

The book is based on material presented at a 1985 workshop and contains thirty full papers and twenty-two reports and poster presentations. The papers all deal with the biological and management problems of conserving small and fragmented (and hence usually disturbed) patches of natural vegetation. This of course is an issue facing the conservation of forest resources in India today; the overall topic is therefore of great concern to conservationists all over the tropics.

Papers are divided into four sections: ecological studies, fragmentation & genetics, monitoring dynamics, and management. Nearly all papers are from Australia and New Zealand. I was unaware as to their depth of interest and expertise in what is a relatively narrow field! Contributions cover theoretical and practical issues, and deal with plants, mammals, birds and invertebrates. Fire Management, edges & barriers, corridors, land use planning, and replanting are management issues covered. I was surprised to see no mention of traslocation of individuals as a means of maintaining genetic heterogeneity in small populations.

The book is in large A4 format, beautifully printed on glossy paper with a wealth of diagrams and plates. Papers are well referenced. It looks expensive, I do not know the price. It is a book for major ecological libraries, not individuals. Concerned biologists should recommend it to their Librarians, and read it!

W. A. RODGERS

## TIGER MOON by Fiona Sunquist and Mel Sunquist. pp 176 (15 x 23) cm.) with many photographs and a relief map. University of Chicago Press, 1988. Price not stated.

The flat lowland, or *terai* region of Nepal has a close-knit mix of habitats - swampy grasslands, riverine and sub-tropical deciduous forests - which provide ideal conditions for a rich and diverse fauna. For over a hundred years upto 1950, the *terai* was protected as a private hunting preserve of the Rana regime. Chitwan, in particular, was considered to be a naturalist's paradise, "an area saturated with tigers ... where rhinos were a positive nuisance".

Following economic pressures, a change of regime and the eradication of malaria, the *terai* was thrown open to al' comers in 1960. This led to a mass migration and two-thirds of Chitwan fell to the plough. Hunting and poaching became rampant, swamp deer and water buffalo were eliminated, and the rhino population dwindled rapidly.

It was realised that urgent action was required if this unique wilderness was to be saved, and in 1964 some 22,000 settlers had to be resettled elsewhere as a prelude to the formation of the Royal Chitwan National Park. The Park covered an area of 210 square miles, which was later extended to 416 square miles.

In 1972, "Operation Tiger" was launched by WWF. As a part of the programme, the Smithsonian Institute set up a long-term Tiger Ecology Project, for which the Chitwan National Park was the site selected. Mel Sunquist, a wildlife ecologist, and Fiona Sanquist, a wildlife writer and photographer, worked on the Project for two years from 1974. Their book, Tiger Moon, tells the story of Chitwan and the pioneering studies carried out there.

It is a fascinating story that runs the gamut of the experiences of the Sunquists and their Nepalese colleagues. The reader shares with them the excitement of discovery, the thrills of close encounters with rhino and tiger, the ambience of the wilderness during day and night, and the gradual unraveling of the social organisation of the tigers of Chitwan.

The crux of the problem was to develop a method of monitoring the movements of several tigers during the day and at night over the duration of the Project. This was tackled by the use of radiotelemetry, a technique that had not been used till then in Asia, or with tigers.

Radio-telemetry involved 'capturing' tigers and fitting them with miniature transmitters embedded in plastic collars. This hazardous operation is vividly described in the book. After the tiger had killed a buffalo bait, it was 'driven' to a selected spot using three elephants and shot with a dart gun. The dart syringe contained drugs which rendered the animal unconscious for over five hours. During that time, it was examined and fitted with a radio-collar. It was also weighed, measured and photographed for future identification, and watched closely till it was able to get up and go away.

Each such transmitter emitted signals on a particular frequency, and these were monitored using a portable receiver which had a directional antenna. By taking compass bearings of two readings and plotting them on a map, the tiger could be located with fair precision. The receiver was carried into the forests on an elephant, or, in the evenings and at night, a vehicle was used on the Park roads.

On one memorable occasion, however, the tracking was done on foot. That was on a cold and foggy night when the "Roaring Tigress" left her home range near the camp and wandered away in search of a mate. Eventually, her urgent calls evoked a response from the Sauraha Tiger, and he was persuaded to follow her all the way back into her range. Both animals had radio-collars, but their vocal efforts sometimes drowned the radio-signals!

The information gathered by radio-telemetry was checked by examination of the sites for pug-marks, territorial markings such as scent, and other signs of tiger activity. To fill in the picture, the tiger's prey - four deer species - and leopards were also studied by radio-telemetry.

Gradually, there emerged a pattern of the tiger's social behaviour that was aimed at maximising the chances of biological success in an environment with abundant prey, cover and water. Chitwan, in fact, was found to have the highest tiger density recorded anywhere in the world.

It was established that tigresses maintained relatively small, exclusive home ranges for hunting and rearing cubs. Most of the ranges were on the floodplains and covered six to eight square miles. On the other hand, tigers had much larger home ranges which overlapped the ranges of several females, but there was little overlap with those of other males. The objective of each sex was to leave as many offspring as possible, but the strategies differed.

This tight social organisation in what was effectively an isolated population raised many questions which are discussed by the authors. These include: the limit to the tiger population, competition for ranges and how they were maintained, the role of the sal forests, dangers of inbreeding, infanticide, and the emergence of man-eaters.

Another aspect, the interaction with human society, is also given due weight, for the authors accept that "learning about the tigers' biology is only a tiny part of what is required to save the species". The conflict of interests between wildlife and some fifty thousand villagers who lived near the Park at that time is discussed, and the authors assess the "practical low-budget methods" adopted by the authorities to tackle the situation. The authors also give an alarming picture of the deleterious effects of fast-growing tourism on the habitats and wildlife.

Preservation of wildlife is perhaps not the key issue. The major benefit of the Chitwan National Park, as the authors demonstrate, is in soil and water conservation. Human activity that upsets this "dynamic and rapidly changing ecosystem" has resulted in floods, erosion and loss of fertility in the surrounding areas.

"Tiger Moon" provides a great deal of information about Chitwan and the *terai.* It is well written and one is tempted to finish it in a single sitting. It will be read with enjoyment by the biologist as well as the lay person.

PRATAP SARAIYA

# MISCELLANEOUS NOTES

## 1. NEW LOCALITY-RECORDS FOR *MYOTIS MONTIVAGUS PEYTONI* WROUGHTON & RYLEY, 1913, AND *MURINA CYCLOTIS CYCLOTIS* DOBSON, 1872 (CHIROPTERA: VESPERTILIONIDAE) IN THE EASTERN GHATS OF ANDHRA PRADESH, INDIA.

In February-March 1985, Shri S.S. Saha, Assistant Zoologist, Zoological Survey of India, made a small collection of bats from the Eastern Ghats of Vishakhapatnam district, Andhra Pradesh. This collection contains two species of montane Vespertilionid bats which have so far not been reported from this area. The two species are described below:

**Myotis montivagus peytoni** Wroughton & Ryley, 1913

*Myotis peytoni* Wroughton & Ryley, 1913. *J. Bombay Nat. Hist. Soc.*, 22 : 13 [Gersoppa Falls (Altitude 1,300 ft.), Kanara, S. India = Gersoppa Falls (398 m), Uttara Kannada district, Karnataka, southwestern India].

**Material examined:** Andhra Pradesh: Vishakhapatnam district: 1 Male: Anantagiri (1052 m), 21 March 1985; 1 Female: Lankapakalu (884 m), 14 March 1985.

**Measurements** (in millimetres):

| | Male | Female |
|---|---|---|
| Forearm | 43.4 | 42.5 |
| Tail | 46.5 | 48.2 |
| Foot & Claw | 7.8 | 9,6 |
| Ear | 15.6 | 14.2 |
| Tragus | 7.4 | 5.3 |
| Tibia | 19.0 | 18.6 |
| Greatest length of skull | 16.9 | 16.2 |
| Condylobasal length | 16.2 | 15.6 |
| Condylocanine length | 15.4 | 14.6 |
| Maxillary tooth-row | 6.7 | 6.7 |
| Mastoid width | 8.6 | 8.2 |
| Cranial width | 7.9 | 7.3 |
| Zygomatic width | 11.6 | – |
| Least interorbital width | 3.9 | 3.9 |
| Canine width | 4.5 | 4.7 |
| Molar width | 7.3 | 7.3 |
| Mandibular length | 12.9 | 12.2 |
| Lower tooth-row | 7.6 | 7.7 |

**Remarks:** Hill (1962) reported *Myotis montivagus* for the first time from northern Burma, and considered *Myotis peytoni* Wroughton & Ryley, 1913 (from western India[1]) and *Myotis peytoni federatus* Thomas, 1916 (from Malaya) as subspecies of *Myotis montivagus* (Dobson 1874). Hill has treated the Burmese population as belonging to the nominate subspecies and the western Indian population to *Myotis montivagus peytoni*. The latter subspecies is distinctly larger than the nominate form (*vide* measurements given by Hill 1962, Das 1987). The present material from the Eastern Ghats, though marginally smaller in some of the measurements, is nevertheless referable to *Myotis montivagus peytoni*. These specimens, therefore, would constitute the basis for the first authentic record of *Myotis montivagus peytoni* Wroughton & Ryley, 1913, from the Eastern Ghats of Andhra Pradesh.

**Murina cyclotis cyclotis** Dobson, 1872

*Murina cyclotis* Dobson, 1872. *Proc. Asiat. Soc. Beng.* : 210 (Darjeeling = Darjiling, Darjiling district, West Bengal, India).

**Material examined:** Andhra Pradesh: Vishakhapatnam district: Wangasara c. 808 m. : 1 Male, 1 Female: 6 & 7 March 1985.

**Measurements** (in millimetres):

| | Male | Female |
|---|---|---|
| Forearm | 31.6 | 34.5 |
| Tail | 37.0 | 36.8 |
| Foot & Claw | 8.4 | 7.8 |
| Ear | 14.6 | 15.5 |
| Tragus | 6.3 | 6.9 |
| Tibia | 16.6 | 17.6 |
| Greatest length of the skull | 15.9 | 16.6 |
| Maxillary tooth-row | 5.1 | 5.6 |
| Mastoid width | 7.9 | 7.8 |
| Cranial width | 7.5 | 7.5 |
| Zygomatic width | 9.3 | – |
| Least interorbital width | 4.0 | 4.1 |
| Rostral width | 3.9 | 4.4 |
| Canine width | 3.6 | 4.3 |
| Molar width | 5.4 | 5.5 |
| Mandibular length | 10.2 | 10.7 |
| Lower tooth-row | 5.46.0 | |

**Remarks:** *Murina cyclotis* Dobson is known from Sri Lanka, northeastern India, western and northern Burma, southern China including Hainan Island, Vietnam, Laos, Thailand, the Malayan Peninsula and Philippines (Ellerman and Morrison-Scott 1951, Hill 1964, 1972; Lekagul and McNeely 1977, Corbet and Hill 1980, Honacki *et al.* 1982, Nowak and Paradiso 1983). Hill (1964) includes Borneo in the distributional range of *Murina cyclotis*. However, no specimen of this species can be traced from that island.

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[1] Hill (1962) inadvertently sites Peshok, near Darjeeling, northeastern India, 3,500 feet, as the type-locality of *Myotis peytoni* Wroughton & Ryley, 1913. The correct type- locality of this taxon is, however, quite different, as given above.

Of the three subspecies of *Murina cylotis* recognised by Hill (1964), *Murina cyclotis eileenae* Phillips, 1932, is known from Sri Lanka, *Murina cyclotis peninsularis* Hill, 1964, from the Malayan Peninsula and southern Thailand while the nominate subspecies is distributed over the remaining part of its range.

So far as the Indian Union is concerned, *Murina cyclotis cyclotis* is reported from Darjiling and some other localities of Darjiling district, Sikkim and Jaintia Hills of Meghalaya (Hinton and Lindsay 1926) only. On the basis of the present specimens, *Murina cyclotis cyclotis* Dobson, is reported for the first time from the Eastern Ghats of Andhra Pradesh.

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I am thankful to the Director, Zoological Survey of India, for providing facilities for this work. Shri S. S. Saha, Assistant Zoologist, Zoological Survey of India, very kindly allowed me to study the collection of bats made by him in the Eastern Ghats of Andhra Pradesh. I am grateful to him for this. My sincere thanks are due to Shri P. K. Das, Scientist 'SD', Zoological Survey of India, for improving the initial draft of this note and for placing certain literature at my disposal. I am also thankful to the Officer-in-Charge, Mammal and Osteology Section, Zoological Survey of India, for providing facilities for the present work.

December 31, 1988. M.K. GHOSH

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WROUGHTON, R.C. & RYLEY, K.V. (1913) : Scientific Results from the Mammal Survey. No. IIIA. – A new species of *Myotis* from Kanara. *J. Bombay nat. Hist. Soc. 22* : 13-14.

## 2. ENDANGERED GRIZZLED GIANT SQUIRREL HABITAT

The grizzled giant squirrel, *Ratufa macroura*, is an endangered species which was reported to be limited to a single population in India, in the Srivilliputtur forests in Tamil Nadu. A recent census[1] conducted during July 1988 in Chinnar Wildlife Sanctuary in Kerala revealed a second habitat, about 100 km north of the first. Chinnar Wildlife Sanctuary lies in the rain shadow region of the Western Ghats. It is bordered in the north and east by Amaravathi reserve forests of Anamalai Wildlife Sanctuary. The extent of the Sanctuary is 90 sq.km. This is one of the areas with least rainfall in Kerala, resulting in dry deciduous forest.

The riparian zones on the sides of the Pambar

[1] The census was conducted by Kerala Forest Department staff, assisted by staff of Wildlife Biology Division, KFRI Peechi.

river and Atti odai (tributary of Pambar) were found to be good habitat for grizzled giant squirrel. There is no published record of the occurrence of this species anywhere in Kerala. Sighting of six grizzled giant squirrels and many dreys in the riparian trees of Atti odai and Pambar river during the census gives hope of its survival in these places. Calls of the squirrels were heard from other parts of the sanctuary also. All sightings were of solitary individuals. The animal was seen feeding on seeds from the ripe fruits of Thutta (local name of a small tree on the riverside).

A detailed survey of the Chinnar Wildlife Sanctuary along with the adjacent Tamil Nadu forests may be rewarding. Considering the extent of the riparian zone, the number of dreys sighted in the area and the spatial location of the calls heard from different parts of the sanctuary, the population could be in the order of 50-75 individuals in this area. In addition to its importance as a grizzled giant squirrel habitat, the sanctuary has a good number of spotted deer, gaur, sambar, wildboar, elephant, panther, human langur, bonnet macaque, peacock and a variety of birds of the dry deciduous region.

November 26, 1988. K. K. RAMACHANDRAN

## 3. INCIDENT INVOLVING A SNAKE AND A PURPLE HERON

On 7 October 1986, at about 4.00 P.M. as I was watching the activity pattern of Sambar *Cervus unicolor* in the marshes of Keoladeo National park, Bharatpur, I noticed a Purple Heron (*Ardea purpurea*) standing from the sambar about 1.7 m away holding a snake in its bill. On closer examination with my telescope I realised that it was Checkered keelback of about 30- 35 cm.

The bird took about five minutes to handle its prey. The snake struggled actively, coiling itself around the bill of the heron. To kill the snake the bird started beating it on a babul tree, *Acacia nilotica*, for some time, then started devouring the entire snake from head to tail.

Interestingly, the purple heron is recorded as feeding on fishes, frogs, molluscs, aquatic insects, small rodents and young birds (Ali, Salim and Ripley, S.D. HANDBOOK Comp. Ed. 1983), but I do not find any published record of its feeding on snakes.

December 30, 1986. MD. NAYERUL HAQUE

## 4. ON THE PARENTAL CARE OF WOOD SHRIKE (*TEPHRODORNIS PONDICERIANUS*)

On 3rd April 1986, I spotted the nest of a common wood shrike in a horizontal branch of a cassia tree about 2-3 metres above the ground. There were 3 eggs and I decided to observe daily the activities, especially the feeding of the hatchlings. The eggs were hatched on April 14 and I could see three blind and naked chicks well-protected by the parent from the hot sun. I waited for a few more days before taking photographs. I expected that feeding activity would be limited in the easily stages, and would increase as the chicks grew, and demanded more food. On April 28th I saw that the chicks were fairly big and overflowing from the small cup-shaped nest. I also found that the lighting was ideal and temperature tolerable. I built a temporary hide, positioned my camera and waited for the arrival of the parents. The parents were suspicious for a while and finally decided to feed the young ones. They were noisy and I saw them sitting on a nearby acacia tree. One of them had something in its beak. The first arrival was the one without anything and it appeared to me that this was an inspection visit, to see everything was alright. Then the other parent followed with the food. During my two hours' observation I could see the birds were mainly bringing praying mantis, grasshoppers and honey bees. It appeared to me that the chicks accepted the food, large or small, depending on how hungry they were. Initially all the three accepted both large and small prey. But gradually I saw them rejecting the big prey, like the praying mantis. Soon, the temperature was rising and I was feeling uncomfortable in the hide. The birds also appeared to be bringing food with lesser frequency. Then I saw one of the birds, after feeding the young ones, stayed in the nest. It sat on the brim of the nest and puffed up the breast feathers and soon the young ones buried their heads in the feathers. This behaviour was definitely to protect the young ones from the hot sun.

October 21, 1986. V. SUNDARARAMAN

## 5. PAINTED STORK *MYCTERIA LEUCOCEPHALA* (PENNANT) SWALLOWING A SNAKE

Painted storks (*Mycteria leucocephala*) are quite common in the environs of Delhi. These beautiful and elegant birds flock annually to breed in the large, natural heronries of the Delhi Zoological Park. Their breeding season lies between September and March, after which they fly away with the new brood and disperse into the countryside, till the next year. About their dietary habits it has been reported and also observed personally that they catch fish, frogs, insects etc. While feeding their young they regurgitate the contents of their crop into the nest or directly into the gaping mouths of the nestlings.

I have been studying some aspects of population dynamics of herons, and the Painted Storks, in the zoo for the past three months. On 19 October 1986 I noticed an adult stork in the nest, holding a peculiar prey in its mandibles. I first suspected it was a fish, but closer inspection through binoculars revealed that the animal in the bill was slender, long, shaped like a 'snooker stick' and did not have even the slightest suggestion of a caudal fin. The only longish fishes known to exist in the zoo ponds are some species of *Channa* (murrel) and *Mastacembelus* (spiny eels). It is unlikely that the bird was holding any of these because no type of murrel can ever pass for a snake in appearance and most spiny eels have a prominent caudal fin or fin fold. However, watersnakes are quite common in these waters and every trip to the zoo results in one or two sightings.

After 5-6 minutes of deliberate effort the stork managed to swallow the snake in the head-on position, while it was still alive and waving its tail feebly. Thereafter, the bird bent down to feed the nestlings which had been clamouring hungrily for food all the while. However, the snake was not ejected immediately. According to Ali and Ripley (1968), Painted Storks may wait for considerable periods of time before disgorging the food in their crops. According to them 'possibly the delay in delivery is due to the necessity of predigesting the food for the young'.

February 13, 1987. ABDUL JAMIL URFI

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## 6. BAER'S POCHARD IN PAKISTAN

I shot a Baer's Pochard (*Aythya nyroca baeri*) in district Gujrat (Punjab-Pakistan) near village Marala on 30th January 1957. This Marala is not the Marala of the upper Chenab Headworks but another place near Chilianwala, a battle-field during the second Sikh war.

The Marala marsh mardh covered more than 100 acres of a depression in an otherwise flat plain. It was amongst the earliest water logged areas to appear as a result of the canal irrigation. The depth of the water varied from a few inches to about 2 feet at the deepest. Most of the area was covered by marsh grasses and rushes, with perhaps about one fifth of the area being clear water. The village buffalo herds graze the marsh.

The spring migration of the wildfowl had started and the numbers varied from day to day. A few days earlier there had been fewer birds, but on that day a new lot of birds, mostly common teal and Mallard, seemed to have arrived. The previous night had been a moonless night and the morning turned out to be cloudy with gusts of high wind and hail. I do not remember there being any abnormal spell of weather.

It was a lone bird and had got up from a small patch of tall rushes. Picking it up, I found it was an unknown type. I had not seen one like it before and on consulting Finn's little book "The water-fowl of India and Asia", I thought it came nearest to the Baer's white-eye, but it should not have been so far west. There had been a small flight of the Common White-eye a few days earlier, but I do not remember seeing any on that day. It had fluttered among the rushes when getting up but had risen straighter up than a common white eye. It was a female on the evidence of its ovary. It did not appear to be wounded or sick.

I had to go away early next morning and so could keep only the head, a wing and a foot, which I sent to the Shooting Times, London, who forwarded them to the British Museum (Natural History). Mr. R. W. Sims of the Bird section wrote to me, "The bird appears to be of the eastern race, *Aythya nyroca baeri;* this is probably a first record from the Punjab". In reply to a further query by me, he replied, "The words 'the bird appears to be' are used because identification rests on only the head. It is therefore remotely possible that, occasionally, birds of the western race can be atypically pigmented. Personally I feel that there is little doubt that your bird is of the eastern race".

December 3, 1986. HAIDER JANG

## 7. AN INTERESTING COLOUR PHASE OF THE LESSER GOLDENBACKED WOODPECKER *(DINOPIUM BENGHALENSE)*

On 29th September 1986, Vijay Shrimali spotted a strange woodpecker and as happens regularly, most of the staff of the Centre for Environment Education, from the Director down were out in the Centre's garden looking at the new bird! It was a Goldenbacked Woodpecker but with a difference: the entire body, apart from a light golden back and a crimson crest, was white with a light creamy tint. The crimson crest indicated the bird was a male. The bird was spectacularly beautiful and was not an albino as proved by the golden back, crimson crest and dark eyes. Later the unusual bird was shown to Shree Shivrajkumar Khacher and he was able to watch it at eye level on a tree trunk at a distance of less than 3 meters!

October 4, 1986. LAVKUMAR KHACHER

## 8. UNUSUAL FEEDING BEHAVIOUR IN THE ADJUTANT STORK *LEPTOPTILOS DUBIUS* (GMELIN)

On the morning of 8th January 1986 at about 0800 hrs., we came across an Adjutant Stork swallowing large pieces of vertebral column at a garbage dump at Tezpur (Sonitpur district) in Assam.

The garbage dump being a major site for the town's waste matter disposal is regularly frequented by 3 species of vultures (*Gyps benghalensis, Gyps indicus, Gyps fulvus*), Pariah Kite, (*Milvus migrans govinda*) and Adjutant Stork (*Leptoptilos dubius*). During one such observation on these birds we came across an unusual feeding behaviour of the Adjutant Stork. The stork was trying to swallow pieces of vertebral column as also some offal. Initially the stork picked up one of the pieces and tried swallowing it. This piece measured not less than 30 cm in length and belonged to a buffalo calf. This was confirmed by regular visits. Inspite of the size of the vertebral column the stork successfully managed to swallow the piece after a lot of effort. The whole operation was repeated 5 minutes later by the same bird when another piece (about the same size as the first) was swallowed. About 10 minutes before this incident the same adjutant stork was seen feeding on a carcass along with 110 Whitebacked vultures, 4 Longbilled vultures, 4 Fulvous Griffon vultures and 7 Adjutant Storks.

Fishes, frogs, reptiles, crustaceans and carrion form the major food of this stork (Ali and Ripley 1983). Panday (1974) has reported the swallowing of maimed ducks by Adjutant Storks.

PRAKASH RAO
May 2, 1987. S. MURLIDHARAN

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# 9. CRANE MIGRATION THROUGH BALUCHISTAN: A PRELIMINARY REPORT

(*With a text-figure*)

## INTRODUCTION

Three crane species, i.e., the Common Crane (*Grus grus lilfordi*), the Demoiselle Crane (*Anthropoides virgo*) and the Siberian Crane (*Grus leucogeranus*) are known to migrate through or over Pakistan in spring and in fall en route to their wintering grounds in India from their normal summering grounds at higher latitudes in Soviet Russia (Roberts and Landfried 1982), though scattered birds have been reported to spend their winters in paddy fields in the Punjab and in desert steppes of Sibi, Kachhi and Nasirabad in Baluchistan. All the presently available reports have placed emphasis on the Kurrum Valley in the N.W.F.P. (Ali and Ripley 1969) and the valley of the River Zhob in the northwestern part of Baluchistan (Landfried 1982, 1983; Roberts 1977), though Archibald (1979) suggested that the records on the distribution and migration of the cranes were very vague. The present paper presents some very preliminary data on the overall migratory pattern of the Common and the Demoiselle cranes through Baluchistan.

## MATERIAL AND METHODS

A tour of the different areas of Baluchistan, i.e. Zhob, Chagai, Kharan, Khuzdar and Sibi was undertaken in different parts of the wintering season, i.e. October through March for the last three consecutive years (1982 through 1984) in connection with our study on the biology and ecology of the Houbara Bustard. During this tour the crane migration was physically observed in different areas. Excited by the sighting of the migrating cranes in certain areas we interviewed a number of local hunters, local populace and the field staff of the Provincial Forest Department so as to extract information regarding

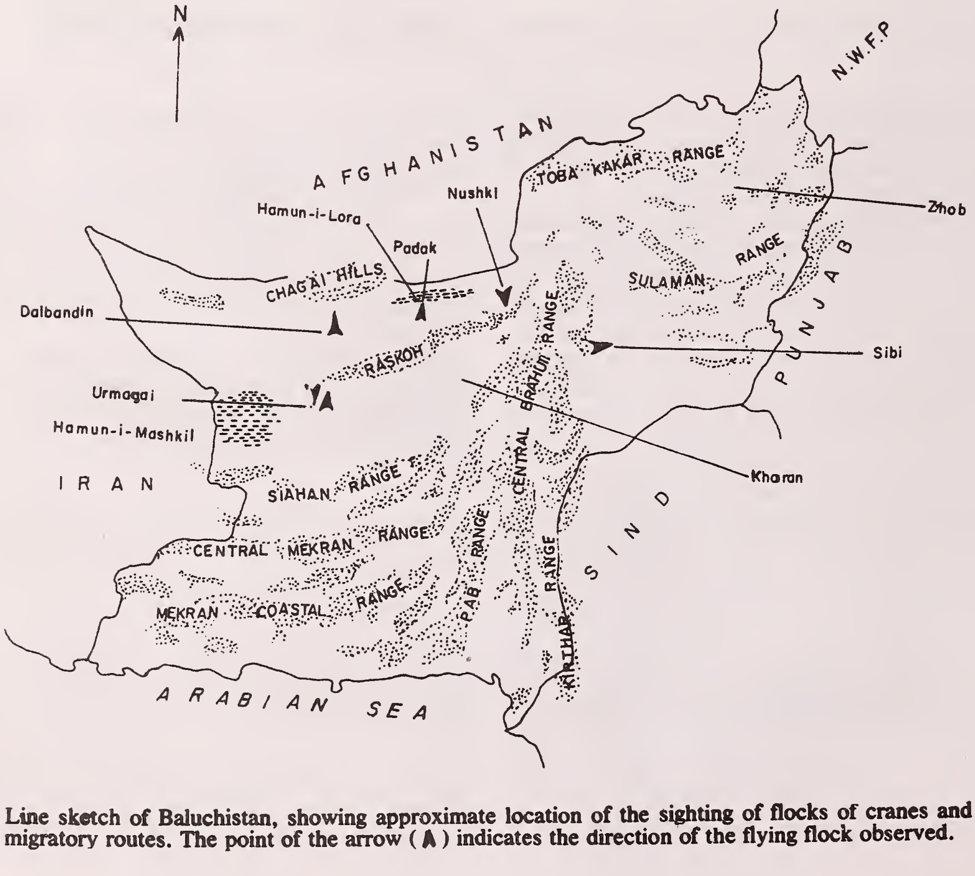
N
AFGHANISTAN
N.W.F.P
TOBA KAKAR RANGE
Zhob
Nushki
Hamun-i-Lora
Padak
CHAGAI HILLS
Dalbandin
RASKOH
SULAMAN RANGE
BRAHUI RANGE
Sibi
PUNJAB
Urmagai
Hamun-i-Mashkil
IRAN
SIAHAN RANGE
CENTRAL RANGE
Kharan
SIND
CENTRAL MEKRAN RANGE
PAB RANGE
KIRTHAR RANGE
MEKRAN COASTAL RANGE
ARABIAN SEA

Fig. 1. Line sketch of Baluchistan, showing approximate location of the sighting of flocks of cranes and tentative migratory routes. The point of the arrow ( ▲ ) indicates the direction of the flying flock observed.

their observations on cranes in their respective areas. The data collected through the interviews was corroborated with our personal observations and was consolidated to evolve a tentative migratory pattern.

## RESULTS AND DISCUSSION

The relevant information regarding sighting of six different flocks of cranes in different areas of Baluchistan is presented in Table 1. Fig. 1 presents a tentative localization of the places on the line sketch. The flocks observed in late March or early April in Dalbandine, Padak and Urmagai with a northward direction of the flight were probably on a spring migration to their summering grounds, while the flocks located in Nushki and Urmagai in the month of October, flying in a southward direction were on their autumn migration towards their wintering grounds. The flock observed in Sibi in late November suggested that these birds comprised a part of a group which winters in the area. It was not possible for us to differentiate between the Common Cranes and the Demoiselle Cranes, but we presume that most of these flocks represented the Demoiselle Cranes. No Siberian Crane was, however, observed. The flock of about 150 cranes observed in Put Chatao area of the Padak on 25th March 1984 had probably passed the previous night in the area and it suddenly took off at about 11.00 A.M. and started its northward migration after hovering over the area for sometime. The nomadic camp-mate settled in the area told us that there were many cranes in the area the previous day and that most of these had probably left the area in the morning.

Our interviews with the local populace suggested that the cranes could be observed for a few days in September-October and in March-April, in Nushki, Padak, Dalbandine, Urmagai, Khuzdar, and Zhob, but not at other times of the year. In Sibi, however, cranes can be observed throughout the winter, though now as a very scattered population, near the paddy fields or near the marshes created by the accumulation of the rain and/or irrigational water. The local inhabitants of the area could not distinguish between the Common Cranes and the Demoiselle Cranes. They call the cranes *'Karkara'* in Zhob (Pushto) and *'Khaakhur'* in Chagai and Kharan (Baluchi). There was no report of seeing the Siberian crane in the area in living memory. The cranes are said to settle in the vicinity of 'Hamuns' (Hamun-i-Lora, Hamun-i- Mashkhel) and 'Kirks' (both Hamuns and Kirks indicate the depressions where the rain water of the area accumulates and forms a marshy area after the drying up of the water, leaving open flat ground) in Chagai and Kharan. They spend 2-3 days in the area, resting briefly in their long flight from or to their wintering areas.

TABLE 1

A SUMMARY OF THE DATA REGARDING SIGHTING OF CRANES IN SOUTHWESTERN BALUCHISTAN

| Date | Area | Approx. Flock Size | Direction of Flight |
|---|---|---|---|
| 3 April 1982 | Dalbandine | 100 | North |
| 25 March 1984 | Padak | 150 | North |
| 27 March 1984 | Urmagai | 50 | North |
| 23 October 1984 | Nushki | 50 | South |
| 30 October 1984 | Urmagai | 50 | South |
| 23 November 1984 | Sibi | 50 | East |

The present preliminary report is the first which indicates that the cranes exploit a much more diffused migratory route than hitherto recognized. Most of the previous reports tend to place emphasis on the Indus River Valley as the main migratory route of all the three species of cranes which happen to migrate from the northern latitudes to pass their winters in the Indian sub- continent (Ali and Ripley 1969, 1977; Landfried 1982, 1983; Roberts and Landfried 1982), though Landfried (1983) has confirmed the cranes' migration through Valley of the River Zhob. Our results suggest that the cranes probably have a much diffused entry point into Baluchistan extending from Zhob to the western flank of the Chagai. It seems that the cranes generally avoid very high mountains during their migration and hence select certain entry points through the valleys. Thus, in western Baluchistan, the birds avoid the Chagai hills and the Raskoh Range. They have not been observed very often in the eastern Kharan, suggesting that the cranes entering the Chagai through diffused routes move into the Kharan mainly through its western part, and probably pass into the Khuzdar area and finally to Sibi, Kachhi, Nasirabad and the Rann of Kutch. Further studies are needed to confirm the exact route exploited for the migration in the area. The population entering through Zhob probably directly enter Dara Ghazi Khan and to other parts of the country.

Though considerable trapping of the cranes is done in the northern areas of Baluchistan, i.e. Zhob, where cranes happen to pass through very defined routes and through narrow valleys, no such regular trapping has been reported in southwestern Baluchistan, except for some very sporadic shooting. This is understandable as in this area, the migration routes are very diffused, extending over 300 km, making it hard to select points for organized trapping parties for mass trapping. This may suggest that this migratory route exploited by the cranes is rather safe and may help in the survival of the species.

It is not possible on the basis of the presently available information to decide whether the selection of this route is made at random by birds in the different Russian breeding populations, or whether some definite populations pass through this route, leaving the other populations to use the migratory route located in the north. Further ringing data may yield interesting information regarding this aspect of the biolgy of species of cranes. It may yield some positive clue regarding the exploitation of this route by the endangered Siberian Crane, if concentrated efforts are taken to determine the extent of exploitation of this migration route by the Siberian Cranes, which may be a considerably safer route for the few individuals of the species now left for future generations.

### ACKNOWLEDGEMENTS

I feel greatly indebted to Mr. K.M. Shams, Chief Conservator and a number of workers of the Baluchistan Forest Department for their whole hearted support during our tours of the area and to the World Wildlife Fund, Pakistan, for providing partial financial support.

November 21, 1986. AFSAR MIAN

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## 10. UNUSUAL INTERACTIONS FOR FOOD

While watching raptors in Keoladeo National Park during the 1985-86 winter, an interesting behaviour among other birds was observed. Around the end of January, painted stork (*Mycteria leucocephala*) young, though fully fledged and out of their nests were still dependent on adults for food. The young in large groups on bare mounds would clamour noisily to be fed on seeing any adult alighting nearby with a begging display that involves deep bowing undulations of the head with wings wide-spread. Egrets on noticing this would hopefully alight nearby waiting patiently ready to pirate or snatch a morsel with a lightning dash during the actual regurgitating feeding act should the opportunity arise. They would then move position from one repleted young to another that was being fed. This behaviour was consistently observed as long as the young continued to be fed. On other occasions egrets were observed to fly in from neighbouring blocks solely on hearing painted stork young begging for food. I have seen egrets flying over from B block to L block, this behaviour being activated on hearing the young's begging vocal display as they could not have witnessed the food bringing arrivals of the adult painted storks, who were observed to delay and sometimes even interrupt feeding to drive off nearby egrets. This behaviour appears odd in the light that the egrets were rarely successful in grabbing a beakfull. They were almost totally dependent on their own hunting ability and yet persisted with this activity. As soon as feeding was over they would promptly leave the immediate area.

On another occasion a painted stork adult was chased and driven up again into the air by a Blacknecked Stork (*Ephippiorhynchus asiaticus*) just as it was approaching its young clicking its mandibles. The blacknecked stork followed it persistently for about 15 seconds till it disgorged a few small fish meant for its young. The Blacknecked Stork was then rejoined by its mate and as they flew across the bund separating L.W. from B block they were determinedly mobbed and chased by the pirated painted stork.

October 29, 1986. RISHAD NAOROJI

# 11. HOUBARA BUSTARD *CHLAMYDOTIS UNDULATA:* A RARE RECORD FROM KERALA

*(With a photograph)*

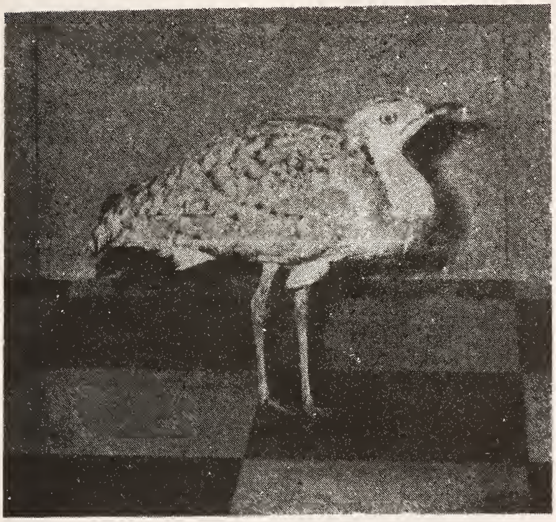

Photo Houbara Bustard (*Chlamydotis undulata*) from Kerala.

On 7th Nov. 1986, a local Malayalam newspaper carried a report with a small photograph about the capture of a rare bird at Kanhangad (*c 12*° 25' N; 75° 5' E) in Kasaragod District, the northernmost district of Kerala. From the photograph, it was obvious that the bird belonged to the Bustard family. A birdwatcher from Cannanore, Mr. C. Jayakumar, went to the place and investigated. The bird was found on 5th Nov. by one Mr. Bhaskaran, an agricultural labourer, in a tobacco field near the seashore at Chettukundu, a coastal village near Kanhangad town. As it was being mobbed by crows, Mr. Bhaskaran captured the bird and took it home, where it attracted a lot of people including the local press, and hence the report. The bird did not accept any food, though water, boiled rice (!) etc. were offered. On 8th Nov. 1986, the flight feathers of the bird were clipped to prevent it from flying away. The bird, which was alive and active till then, suddenly bled from its notrils and died soon after. It was later identified as a Houbara Bustard. *Chlamydotis undulata*.

According to Ali & Ripley (1983) the Houbara Bustard is a common winter visitor to Pakistan, straggling east to Delhi. It is commonly seen in western Rajasthan and Gujarat, especially Kutch. It has never been reported from south India, and this is the first record. As November is the migratory season, I think the bird accidentally drifted away, got disoriented and landed up in Kerala. The bird was being mobbed by crows it was easily picked up; this proves that it was injured and lost.

## ACKNOWLEDGEMENT

I wish to thank Dr Asad R. Rahmani of the BNHS for commenting on the manuscript.

July 14, 1987. C. SASIKUMAR

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# 12. ON THE OCCURRENCE AND STATUS OF RINGED PLOVER *CHARADRIUS HIATICULA* (LOWE) IN MADRAS CITY (SOUTHERN INDIA)

In the last eight years of active birdwatching in Madras, I have observed and recorded the Ringed Plover (*Charadrius hiaticula*) in Madras, at the Adyar Estuary, on no less than 53 occassions.

This species closely resembles the Little Ringed Plover (*Charadrius dubius*), a more common and widespread species, but *hiaticula* could always be distinguished from the former by the following characteristics: the more robust appearance, the brighter (orange) leg colour, the orange-based black bill, the presence of the white wing-bar seen in flight, the facial pattern and by its distinctive call-notes. On several occasions, both species were noticed side by side and a comparison was possible. The Ringed

Plover *(hiaticula)* was usually present on the mudflats of the river in small groups of 4 or 5 birds and occasionally up to about a dozen or so.

It is very interesting to note from Table 1 that all the sightings of this species have been in the four months from January to April, although I have a doubtful record of it on 2nd September 1984. The earliest recorded date of the *hiaticula* in Madras was on 2nd January (1983) and the last on 29th April (also in 1983).

The water level of the Adyar river is quite high between the months of May and October and the sandbars and mudflats remain inundated during this period, depriving the Ringed Plover of its favourite habitat. I presume that this is perhaps the reason why I have not been able to record *hiaticula* here earlier in the season. The sandbar blocking the river mouth is washed off during the course of the (Northeast) monsoon that is normally active between October and November. Thereafter the river comes under tidal influence and mudflats and sandbars appear at low tide.

My observations indicate that the Ringed Plover is not all that uncommon as is suggested by Ali and Ripley (1983) - to quote: "Straggler or very rare winter visitor, possibly sometimes confused by observers with Little Ringed Plover, and in immature plumage with Lesser Sand Plover. So far recorded with specimens only from Gilgit (1881, *GF* 9 : 359), Sultanpur near Delhi (1879, *SF* 8 : 197) and Maldive Islands (1958, *JBNHS* 60 : 571). Authentically sight-recorded: Karachi Harbour (C.B. Ticehurst, *Ibis* 1923 : 655), Jaffna Peninsula, Ceylon (G.M. Henry 1944, *Loris* 3 : 132)." Abdulali and Hussain (1971) have recorded this species in February 1970 at Muthupet, Thanjavur District, Tamil Nadu. Subsequently, I understand that the Avifauna project has also come across this species at Pt. Calimere. However, no further information could be elicited on these records. It would be interesting to compare the dates of arrival and frequency of sightings of the Ringed Plover in the two areas.

TABLE 1

SUMMARY OF SIGHTINGS OF THE RINGED PLOVER AT THE ADYAR ESTUARY, MADRAS CITY

| Year | Jan. | Feb. | Mar. | April | Total |
|---|---|---|---|---|---|
| 1979 | - | - | - | 1 | 1 |
| 1980 | - | - | - | 2 | 2 |
| 1981 | - | - | 3 | 3 | 6 |
| 1982 | 3 | 2 | 4 | - | 9 |
| 1983 | 3 | 2 | 4 | 7 | 16 |
| 1984 | - | - | 1 | 3 | 4 |
| 1985 | 1 | 3 | - | 1 | 5 |
| 1986 | 1 | 1 | 5 | 3 | 10 |
| | | | | Total | 53 |

December 20, 1986. V. SANTHARAM

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## 13. AN HITHERTO UNRECORDED NESTING SITE OF A REDVENTED BULBUL *PYCNONOTUS CAFER* (LINNAEUS)

On 25th July 1986, I noticed a nest of a Redvented Bulbul in an unusual habitat. It was placed on a dried *Acacia arabica* twig which was lying on a thick mat of floating water hyacinth (*Eichhornia crassipes*), in the Manasarovar area of the Keoladeo National Park, Bharatpur, and was well concealed by the water hyacinth. The water hyacinth was about 72 cm tall, and the nest, cup-shaped and made of dried grass, was about 22 cm above the water level. The acacia twig acted as a base of support to the nest, around which it was wrapped. On the day it was found it contained one egg. Another was added the following day. But unfortunately on the 28th the eggs were missing, probably predated.

Considering the fact that as a rule Redvented Bulbuls build their nests in shrubs, hedges and on slender branches of trees, normally at heights between one and three metres, the present nesting site appears unique.

September 26, 1986. C. NANJAPPA

## 14. REDVENTED BULBUL *PYCNONOTUS CAFER* (LINNE) EATING PETALS OF *MAGNOLIA*

Redvented Bulbuls *Pycnonotus cafer* (3 pairs) live in and around our cottage, breed in low bushes and raise their young. We enjoy watching them. *Magnolia gradiflora* is an introduced tree in the gardens in Nilgiris. We have one medium-sized tree in the compound. The tree is in flower during November, December, February and March. The Redvented Bulbuls feast on the petals, regularly, all day. There are other birds, in and around our cottage, like the spotted doves, sparrows, the Jungle Crows and Black Bulbuls. But only the Redvented eats the petals. At one sitting, one bird eats up the exposed half or more, of one petal.The petals of *Magnolia* are large: to give an idea of size, a - bulbul can be wrapped up in one petal. Petal feeding of an exotic is interesting adaptation.

December 10, 1986. J. MANGALRAJ JOHNSON

## 15. A NOTE ON ROSERINGED PARAKEET *PSITTACULA KRAMERI* FEEDING ON THE LEAVES OF *SALVADORA PERSICA* IN THE POINT CALIMERE WILDLIFE SANCTUARY.

On 29th November 1986 at 0610 hrs, while observing birds visiting a *Fluggea leucopyrus* shrub in fruit on the north side of Muniappan Eri, I saw five Roseringed Parakeets suddenly land on a nearby *Salvadora persica* tree with no flowers or fruits. Two of the parakeets perched on a branch facing me and the other three on another branch facing in a different direction. The two parakeets (both females) started eating the fresh leaves of the plant. At 0616 hrs when I stood up to watch the three parakeets on the other branch, all the five birds flew away. Fruits, cereal, grain, seeds of all kinds, flower petals and nectar of *Salmalia malabarica, Erythrina indica, Butea monosperma, Bassia latifolia* have so far been recorded as food items of Roseringed parakeets (Ali & Ripley, HANDBOOK 1983). The leaves of *Salvadora persica* now form an additional food item of the Roseringed parakeet.

December 20, 1986. P. BALASUBRAMANIAN

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## 16. SOME OBSERVATIONS ON THE BREEDING OF PARADISE FLYCATCHER, *TERPSIPHONE PARADISI* (LINNAEUS) (MONARCHINAE)

The Paradise flycatcher *(Terpsiphone paradisi)* is very uncommon, though widely distributed, in Bangladesh. It generally inhabits the cool, damp areas shaded by bamboo groves, mango trees, tamarind trees, etc. So far, we have recorded the occurrence of this bird from Cox's Bazar forest, Modhupur forest, Sardah near Rajshahi, Rajshahi University campus and Dhasara, Manikganj near Dhaka.

On 5th May 1986, during one of our field trips, we found a breeding pair of Paradise flycatcher (brown phase) at Dhasara, Manikganj about 63 km west of the metropolitan capital, Dhaka. The nest was complete and empty. It was built in the extreme fork of a small branch of a mango tree *(Mangifera indica)* about 4 m in height. The area was shaded by bamboo groves, lofty *Tamarind indica, Delonix regia, Artocarpus integrifolia, Cocos nucifera, Phoenix sylvestris, Borassus flabellifer,* mandar (local name), guava, etc. The area also supported some climbers, creepers, bushes, herbs, shrubs and epiphytes. There was a nest of a Bronze-winged drongo *(Dicrurus aeneus)* with four hatchlings, about 3 m away and 1.5 m higher than the nest under observation. Also there was a nest of a Pied myna *(Sturnus contra)* about 5 m away. Moreover, there was a nest of Toddy Cat *(Paradoxurus hermaphroditus bondar* Desmarest) with three young on top of a date-palm tree *(Phoenix sylvestris)* at the height of about 7 m from the ground and 5 m away from the Paradise flycatcher's nest. A busy village bridle-path went near the nest and all through the day people were utilising it. A village home was also located about 12 m away. The overall picture of the area was that of the backyard of a village.

The four eggs were laid over a six-day period in May 1986. The measurements and weights of the eggs and the dates on which they were laid, are given in Table 1. The colour of the eggs was a light pinkish white with brown blotches. These irregular blotches were more concentrated at the round end rather than at the pointed end of the eggs.

The breeding Paradise flycatchers showed feeble territorial behaviour. On several occasions they chased the jungle crow, magpie robin, tailor bird, jungle myna, common myna, etc. which came near the nest. In most of the cases the breeding pair used to fly to the nearest high branch and gave alarm calls, something like *chen-n-nk, che-n-nk*. The pair of *D. aeneus*, which were nesting nearby would come to their help and drive the intruder out of sight....some kind of symbiotic relationship.

Observations from 13th May to 28th May 1986 were not possible as we had to leave for the Sunderbans to survey the saltwater crocodiles there. So we are unable to calculate the time spent by the breeding birds to incubate the eggs.

We started observing them from 29th May. On 30th May, 1986 the first young was hatched at 1105 hours (BST). At that time the male bird was at the nest incubating the eggs. The male got up from the eggs and observed them very minutely with neck stretched and head inclined on the left side. Then it pecked at one of the eggs, breaking the shell and we saw the swaying neck and head emerge from the egg. The male helped the young out of the shell. Then the male flew away, taking with it the shell remnants to dispose them off far away. He produced certain sounds probably informing the female that he had become a father. The nest was then visited by the female, who too seemed to be excited as it surveyed the nest very keenly and hopped around the nest flickering and spreading the tail and wings. Then it flew away. After some time the male visited the nest with a very small, yellow coloured insect larvae at the tip of his beak. The chick with closed eyes instinctively opened its mouth at the approaching calls of the male. The male fed it - the first meal of the chick. Both the parents incubated the remaining eggs and fed the chick frequently. The feeding frequency was 10 times per hour. Hatching dates are shown in Table 2. Again there was a break in our observation from 3rd-5th June, 1986.

We went to the nest site on the morning of 6th June and were quite amazed to find only two chicks in the nest. After some long, patient observation we understood that the chicks were predated by the jungle crow *(Corvus macrorhynchos)*. It was further confirmed by the absence of the Bronzewinged Drongo, which had left the nest along with its four fledgelings and has made it easy for the jungle crow to attack the Paradise flycatcher hatchlings. During our observation from 1000-1600 hours (6th June) we observed some attacks on the nest by jungle crows but they were chased by the male. Most of the time the male used to sit on a nearby branch giving frequent alarm calls and the female remained busy in feeding the hatchlings. This behaviour has some significance, where the male guards the nest by keeping off the predators and the female feeds the hatchlings.

The following day (7th June) one more hatchling was taken away by the jungle crow. The parent birds tried their best to chase it away but all their cries and pecks were in vain. Due to some unavoidable reasons we left that place in the evening so we are unable to inform about the fate of the last hatchling. We can assume that it did not survive.

This work could have been done more satisfactorily had we been able to devote more time in the field or had some student who could spend his time observing and taking notes on these breeding birds but it was not possible. We do expect that what we have observed would be of use to somebody who studies the Paradise flycatcher in detail in the future.

TABLE 1

MEASUREMENTS OF THE EGGS OF PARADISE FLYCATCHER

| Egg No. | Laid on | Length (cm) | Breadth (cm) | Weight (gms) |
|---|---|---|---|---|
| 1 | May 7, 1986 | 2.4 | 1.8 | 2.913 |
| 2 | May 9, 1986 | 2.3 | 1.6 | 2.730 |
| 3 | May 10, 1986 | 2.3 | 1.6 | 2.725 |
| 4 | May 12, 1986 | 2.1 | 1.5 | 2.195 |
| | Average: | 2.275 | 1.625 | 2.640 |

TABLE 2

INCUBATION PERIOD OF EGGS (IN DAYS)

| Egg No. | Laid On | Hatched On | Incubation Period |
|---|---|---|---|
| 1 | May 7 1986 | May 30 1986 | 23 days |
| 2 | May 9 1986 | May 31 1986 | 22 days |
| 3 | May 10 1986 | May 31 1986 | 21 days |
| 4 | May 12 1986 | June 2 1986 | 21 days |
| | | Average: | 21.75 days |

ACKNOWLEDGEMENTS

We are grateful to Mrs. Fatema Khatun for her cordial reception, hospitality and making our stay comfortable. We also thank her grandson, Swapan for his help in making and fixing the hide-out.

S. M. A. RASHID
ANISUZZAMAN KHAN
November 21, 1986. RAGUIBUDDIN AHMED

## 17. OCCURRENCE OF THE WHITECOLLARED KINGFISHER, *SAUROPATIS CHLORIS OCCIPITALIS* (BLYTH), IN THE GREAT NICOBAR ISLAND

There is some confusion regarding the occurrence of *Sauropatis*[1] *chloris occipitals* (Blyth) in the Great Nicobar Island. Hume found it on all the Nicobar Islands, and in his general account (1874 : 75) mentions seeing it along with other birds at Galatea Bay, Great Nicobar. Abdulali (1967 : 175) said, "We did not notice it on Great Nicobar and I cannot trace any specific record of its occurrence there, nor is any specimen from Great or Little Nicobar listed in Sharpe's Catalogue (Sharpe 17 : 265). It is possible that Hume has erred as in the case of the Cattle Egret." Ali & Ripley (1970 : 406) restricted its distributional range to Camorta, Central Nicobar. Again, he stated (1979 : 762), "We saw it too at Galatea Bay, Great Nicobar Island". Ripley (1982 : 210) maintained its occurrence in the Nicobar Islands.

While working out a recent collection of birds from South Bay, 45 km post on NS Road, Great Nicobar Island, made on 4 and 15 July 1984 by our colleague, Shri S. S. Saha, we came across four examples of kingfishers which proved to be *Sauropatis chloris occipitals* (Blyth). All the specimens which had non- breeding gonads, measure (in mm). as shown in Table 1

TABLE 1

| | Wing | Tail | Bill from skull | Bill from anterior margin of nostril |
|---|---|---|---|---|
| 2 Females | 105, 108 | 69, 72 | 49, 53 | 37, 39 |
| 2 Males | 104, 109 | 68, 75 | 50, 55 | 37, 39 |

Of these four, a male and a female bearing Z.S.I. Reg. Nos. 35691 and 35692 appear to be young birds having the feathers of the breast narrowly edged with black; upperparts resemble those of the adult but are not so brilliant in colour; lower parts are more fulvous than in the adult.

These examples, therefore, serve as the first authentic collection of the bird from the Great Nicobar Island.

ACKNOWLEDGEMENTS

We are grateful to the Director, Zoological Survey of India, for giving us the opportunity to study the material. We express our deep sense of gratitude to Dr. B. Biswas, Joint Director (Retired), for critically going through the manuscript and suggesting improvements. It is pleasure to thank Shri S. K. Sett for typing the manuscript.

J. M. DASGUPTA
December 3, 1986. SIPRA BASUROY

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[1] Regarding the use of the Generic name *Sauropatis* in preference to *Halcyon*, see Mukherjee and Dasgupta (1973).

# 18. FIRST RECORD OF A SKIN NEMATODE ON AN INDIAN MUGGER CROCODILE (*CROCODYLUS PALUSTRIS*)

(*With a text-figure*)

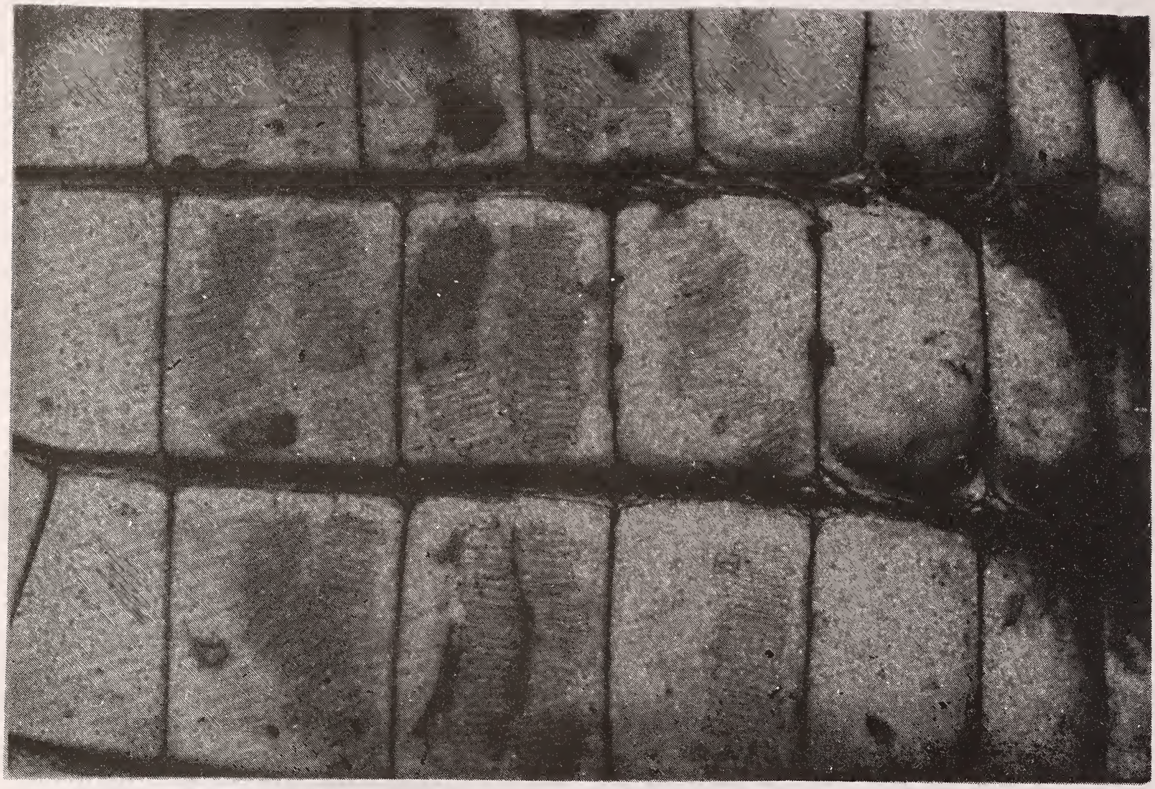

Fig. 1. Skin nematode "tracks" on the ventral skin of a *Crocodylus palustris* at Madras Crocodile Bank.

The presence of "serpentine tunnels" on the belly skin of crocodilians has been reported in literature on the skin trade (King and Brazaitas 1971). More recently Ashford and Muller (1978) described a new genus and species of nematode *(Paratrichosoma crocodilus)* found on skins of the New Guinea crocodile *(Crocodylus novaeguineae)*. In their paper they describe their morphology and what little is known of the habits of these nematodes and point out that similar nematodes have been found in monkeys and tree shrews.

While the worms may not cause any pathological effects in crocodilians, their trails or tunnels can damage the skin significantly in commercial terms (see Figure 1). The first record of such a nematode in India was made at the Madras Crocodile Bank in 1983 on the mugger crocodile *(Crocodylus palustris)*, when one living animal was found to have nematode trails on portions of its ventral scales as shown in Figure 1. No worms were collected, so it is not certain which nematode we have here, but it is planned to attempt to collect the parasite the next time it is detected in one of our crocodiles.

ACKNOWLEDGEMENT

We wish to thank Romaine Andrews for typing the manuscript.

ROMULUS WHITAKER
HARRY ANDREWS

April 23, 1988.

## 19. MUGGER *(CROCODYLUS PALUSTRIS)* EATING SOFT-SHELL TURTLE

On 4 August 1988, as I sat watching crocodiles from Jogimahal in the Ranthambhor National Park, together with Shri V.D. Sharma, Chief Wildlife Warden of Rajasthan and Shri J.S. Nathawat, Field Director of the Park, I saw a large soft-shell turtle floating upside down. Close by was the snout of a fair sized mugger. The legs and the head of the turtle jutted out in *rigor mortis*. The crocodile grabbed these protuberances and pivoted around on the surface of the water, rotating the large flat carapace of the turtle also into a spin, amidst considerable splashing. This, the crocodile did on a number of occasions with respites in between and with the shell coming to rest sometimes on its back with the undersurface showing and sometimes with the carapace in view. A powerful monocular lens showed that the crocodile had been able to tear out certain portions of the legs, which showed dark blood and torn pieces of flesh. There was no attempt to crush the flat and narrow though outsize soft-shell. It is possible that the very large sized body of this soft- shell turtle had resulted in its floating on the top and prevented the crocodile from pulling it under water. Its actions had aroused the interests of 8 other crocodiles, which swam and watched it while floating on the water from a distance of 2 to 20 metres. One crocodile, almost as large as the one which was in possession of the carcass, swam almost within touching distance of the floating carcass, but did not actually grab it. Its attentions prompted the crocodile-in-possession to swim away with the carcass of the turtle into a bed of reeds and thus out of view. It progressed with the shell with the carapace upwards being held in the jaws of the crocodile and being pushed from behind as the crocodile swam.

While the distance prevented the precise identification of the species of turtle, its flat, oval shape, plain surface of the carapace on the back and the yellow colour of the underside seemed to indicate that it was a very large Indian Flapshell Turtle *(Lissemys punctata punctata)*. It was most definitely a soft-shell turtle.

August 27, 1988. RANJITSINH

## 20. THE GANGES SOFT-SHELL TURTLE (*TRIONYX GANGETICUS* CUVIER) FROM VADODARA CITY

Gujarat State has been affected by drought for the last three years. Most of the rivers, lakes and ponds have been going dry. I record here occurrence of a species of turtles not reported previously from Vadodara city[1].

The Ganges soft-shell turtle *(Trionyx gangeticus)* occurs in the River Tapi and R. Narmada (Das 1985), River Mahi, R. Vishavamitri and in R. Sabarmati at the confluence with River Vartak, Temple tank of Daker (Panch Mahals) and lakes and ponds around Vadodara city. Also reported from the Malegaon forest of the Dangs district (Sharma 1982).

The Raja Rani talao (= pond) near the Panigate area of Vadodara city dried up during the month of April 1988. The turtles were in a difficult situation as only a small muddy puddle remained. During the day the turtles moved in the puddle and the turtle's head was often seen coming out for breathing. They tried to migrate from the talao at night and were seen on the adjoining road, but there is no other water reservoir nearby.

We removed 67 (Table 3) of the turtles from the Raja Rani talao and after measurement (Tables 1 & 2) released them in the Sarasiya talao near the Varasiya area of Vadodara city. The turtle transfer operation was done by the zoo staff.

The carapace colour is dark olive-green above with no markings on the shell. The head dark greenish, with three to five oblique black streaks and a black bar from the eye to the nape. These markings are broken in most of the specimens and entirely lost in old specimens, with carapace length above 85.0 cm. The plastron was pale yellow and some were light pink-white. The callosities were not well defined.

The shape of carapace was low humped and oval, and in old specimens, well humped. A deep groove on the middle line of the carapace and two tumbler-shaped bones developed near the bridge of the carapace and plastron on the marginal scute between fore and hind feet, in some of the old specimens.

56 (84%) out of 67 turtles were excess of size mentioned in the available literature (71.0 cm. carapace length; Das 1985). During the operation smaller turtle's size, carapace length (CL) 35.0 cm.; carapace width (CW) 30.5 cm., and plastron length (PL)

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[1] A report that more than one hundred Indian roofed terrapin, *Kachuga tecta* (Gray) were collected by Mr. Dev Raj Matang and Mr. Jayanti Golaniya from the Sabarmati river near the Indroda village & Koba village of the Gandhinagar district.

TABLE 1

THE CARAPACE SIZE (IN CM) OF GANGES SOFTSHELL TURTLES
(*Trionyx gangeticus*)

| No. | Carapace Length | Width | No. | Carapace Length | Width | No. | Carapace Length | Width |
|---|---|---|---|---|---|---|---|---|
| 1. | 78.0 | 62.0 | 20. | 82.0 | 70.0 | 39. | 85.0 | 70.0 |
| 2. | 79.0 | 64.0 | 21. | 83.5 | 69.5 | 40. | 77.0 | 67.0 |
| 3. | 79.0 | 68.0 | 22. | 82.5 | 64.0 | 41. | 72.5 | 63.0 |
| 4. | 80.0 | 66.0 | 23. | 90.0 | 75.0 | 42. | 79.0 | 64.0 |
| 5. | 82.0 | 73.0 | 24. | 73.0 | 62.0 | 43. | 82.5 | 71.0 |
| 6. | 82.5 | 66.0 | 25. | 80.0 | 65.5 | 44. | 86.0 | 72.0 |
| 7. | 83.5 | 72.0 | 26. | 88.5 | 76.0 | 45. | 82.0 | 73.0 |
| 8. | 75.0 | 60.0 | 27. | 72.5 | 62.0 | 46. | 77.0 | 64.0 |
| 9. | 82.0 | 70.0 | 28. | 77.2 | 64.0 | 47. | 83.5 | 72.0 |
| 10. | 79.0 | 67.0 | 29. | 72.0 | 63.0 | 48. | 77.0 | 66.0 |
| 11. | 79.0 | 64.0 | 30. | 80.0 | 67.0 | 49. | 80.0 | 67.0 |
| 12. | 80.0 | 70.0 | 31. | 84.0 | 67.0 | 50. | 82.0 | 69.0 |
| 13. | 75.0 | 67.0 | 32. | 81.5 | 68.0 | 51. | 42.0 | 35.0 |
| 14. | 79.0 | 67.0 | 33. | 81.0 | 70.5 | 52. | 49.0 | 41.0 |
| 15. | 84.0 | 78.0 | 34. | 74.5 | 65.0 | 53. | 39.0 | 31.0 |
| 16. | 82.0 | 67.5 | 35. | 77.0 | 65.5 | 54. | 35.0 | 30.0 |
| 17. | 87.5 | 75.0 | 36. | 89.0 | 75.0 | 55. | 75.5 | 63.0 |
| 18. | 79.0 | 67.0 | 37. | 73.5 | 61.0 | 56. | 36.5 | 32.0 |
| 19. | 81.0 | 70.5 | 38. | 82.0 | 72.0 | 57. | 73.0 | 64.0 |

TABLE 2

THE SHELL SIZE (IN CM) OF GANGES SOFTSHELL TURTLES
(*Trionyx gangeticus*)

| No. | Carapace size Length | Width | Plastrol size Length | Width |
|---|---|---|---|---|
| 1. | 87.5 | 75.0 | 59.0 | 62.0 |
| 2. | 94.0 | 78.5 | 61.0 | 61.0 |
| 3. | 88.0 | 73.5 | 61.0 | 61.0 |
| 4. | 84.5 | 73.0 | 58.0 | 57.5 |
| 5. | 86.0 | 76.0 | 59.0 | 59.0 |
| 6. | 83.0 | 67.5 | 55.0 | 58.0 |
| 7. | 86.0 | 72.0 | 58.0 | 57.0 |
| 8. | 81.0 | 68.0 | 55.5 | 53.0 |
| 9. | 77.0 | 63.5 | 52.5 | 55.0 |
| 10. | 77.0 | 62.0 | 53.0 | 52.5 |

(Weight 67.0 kgs.)

TABLE 3

| Date of Collection | Number of Turtles |
|---|---|
| 13th April, 1988 | 16 |
| 15th April, 1988 | 13 |
| 19th April, 1988 | 16 |
| 20th April, 1988 | 17 |
| 21st April, 1988 | 5 |
| Total | 67 |

25.0 cm; plastrol width (PW) 22.6 cm were also collected. The largest turtle had a size CL 94.0 cm., CW 78.5 cm., PL 61.0 cm., and PW 61.0 cm., and a weight 67.0 kg.

I am thankful to the Curator and other staff of the Sayaji Baug Zoo, Vadodara city.

July 14, 1988. RAJU VYAS

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# 21. SOME OBSERVATIONS ON GROWTH OF THE TRAVANCORE TORTOISE (*GEOCHELONE TRAVANCORICA*)

Since 1977 we have been keeping 2 males and 2 females of *Geochelone travancorica* in captivity. They are housed in concrete floored cages along with birds. They are fed on vegetable scraps, spinach leaves and lucerine grass. The birds are fed "bird seed" and soaked gram and the tortoises were seen eating soaked gram. They were also observed eating a dead parrot, and thereafter they were also fed minced meat.

The tortoises laid eggs on the concrete floor, and these were never damaged. The eggs were collected and placed in a dry terrarium with a tray of water. The terrarium was kept indoors and did not receive direct sunlight.

Eggs were laid for the first time in 1980. On 14 January 1981, three eggs, weighing 47 gm, 46 gm, and 47 gm each were laid. One of these hatched on 11 June 1981. The young weighed 32 gm, but it died soon after hatching. The hatchling looked abnormal, its body being broader than long.

In late January 1983 three eggs were laid, out of which one egg started pipping on 22 June 1983, 16.00 hrs. The hatchling was seen to be upside down. When seen again at 20.00 hrs. the shell had broken, and the tortoise was still upside down. Cockroaches had started attacking the placental remains and unabsorbed yolk sac, hence the hatchling was removed and kept in a polythene bucket with moist moss from the terrarium where the eggs had been kept for incubation. The hatchling was not very active and remained partially within the shell. When seen last on 23rd June at about 22.10 hrs., the yolk sac was still protruding. On 24th June (07.00 hrs.) the hatchling had moved out of the shell, and by evening the yolk sac was absorbed but the suture was not completely closed. When the tortoise had hatched, its body was broader than long but it came to normal shape by 24 June 1983, evening. The young did not survive for more than a week.

In 1985 three eggs were laid on 18 January 1985, and their weights were 47 gms each. The eggs were candled every week. In the late 4th week one was showing definite development. On 7th June 1985 the fertile egg started pipping, and next morning the young had hatched. The young tortoise was 5.5 cm. long and 6 cm. broad, weighed 35 gm. and the empty shell 10 gm.

OBSERVATION OF LENGTH, WIDTH AND WEIGHT OF THE HATCHLING

| Date | Length (cm) | Width (cm) | Weight (gm) |
|---|---|---|---|
| 7 June 1985 | 5.5 | 6 | 35 |
| 14 June 1985 | | | 35 |
| 22 June 1985 | 6 | 6 | 35 |
| 29 June 1985 | | | 43.5 |
| 6 July 1985 | 6.3 | 6.3 | 43.5 |
| 13 July 1985 | | | 43.5 |
| 20 July 1985 | 6.5 | 6.3 | 55 |
| 27 July 1985 | | | 59 |
| 3 Aug. 1985 | 7.1 | 6.6 | 64 |
| 10 Aug. 1985 | | | 67 |
| 24 Aug. 1985 | 7.4 | 6.7 | 78 |
| 8 Sep. 1985 | 7.7 | 7 | 84 |
| 22 Sep. 1985 | | | 83 |

The hatchling was offered Farex mixed with bread and milk several vegetables like tomato, cabbage, lucerine and spinach leaves, cucumber and minced meat in the 4th week. Out of this only Farex mixed with bread and milk was taken regularly, and ripe tomatoes and minced meat were taken occasionally.

The only record of the smallest juvenile, probably an hatchling, is by J. Vijaya (Hamadryad 8, No. 3, page 13) of carapace length 60 mm.

A record was maintained of the weight and size of the young from the day of hatching (7 June 1985).

It was observed that for the first two weeks there was no increase in weight, and the weight increase started from the third week onwards. In the sixth week there was a sudden increase in weight by 11.5 gm. From the sixth week onwards a continuous increase in weight was observed.

LEENA S. SANE
S. R. SANE

July 20, 1988.

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## 22. RANGE EXTENSION OF *CHRYSOPELEA ORNATA* SHAW (REPTILIA : COLUBRIDAE) WITH COMMENTS ON THE DISTRIBUTION OF SOME SNAKES IN NORTH INDIA

*Chrysopelea ornata* Shaw, variously named Golden Tree Snake (Smith 1943) and Ornate Flying Snake (Whitaker 1978) has been recorded to range over the whole of the Indo-Chinese region extending in the northwest to Darjeeling district in Bengal, Patna, Buxar in Bihar and Orissa (Smith 1943). It has also been recorded from the Western Ghats south of Goa (Whitaker 1978) and recently from the "Dangs" (Rao 1987).

In a collection of snakes at the Gharial Rehabilitation Centre, Katernia Ghat, District Bahraich, Uttar Pradesh (long. *c.* 81° 15'E) collected by Ajay K. Srivastava, a specimen unmistakably of *Chrysopelea ornata* was noticed. Since the specimen was poorly preserved, some basic scale counts were made and the pattern of cross-bars noted to confirm the identification. Given below are some scale counts in the specimen along with those reported by Smith.

| | Katernia Ghat specimen | Smith |
|---|---|---|
| Ventrals | 214 | 213-234 |
| Caudals | 115 | 120-138 |
| Scale rows | 18:16 | 17:17:15 |

The Katernia Ghat specimen had 70 cross-bars on the body with an enlarged vertebral spot at the position of the tetra- petalous spot in the live snakes. In view of all these points of resemblance, there is very little doubt that the specimen was one of *Chrysopelea ornata*. This is the first time that this species has been reported from an area which lies some 350 km. in a westerly direction from Buxar, the western extremity of its range in the Gangetic plains reported so far.

Smith's zoogeographic scheme for the herpetofauna of North India assigns extant species to mainly the Indian subregion of the Oriental region. This sub-region has been further distinguished into areas of different faunal characteristics, north and north-central India being covered by five such areas, viz. (i) the desert area of northwest India, (ii) Kashmir and Western Himalayas, (iii) Gangetic plains, (iv) Central India, (v) Chota Nagpur area. A part of north India, viz. the Eastern Himalayas extending from Western Nepal to the termination of the range at the bend of the Brahmaputra, has been excluded by Smith from the Indian sub-region and included with other areas of the Indo-Chinese sub-region because of their faunal affinities.

Of interest here are the Gangetic plains which contain several elements of Assam and eastern Himalayas and the Chota Nagpur area. In Table 1 are listed 13 Ophidian species which have been recorded extensively and basically from the eastern

Himalayas and the Chota Nagpur area with isolated records from further west or Uttar Pradesh (United Provinces in Smith). Many references in Smith do not include locality, while some mention Faizabad. The occurrence of species such as *Lycodon jara*, which has been reported by Whitaker from U.P. based on a specimen collected by the author at Katernia Ghat, and others such as *Chrysopelea ornata, Dendrelaphis tristis* and *Bungarus fasciatus* which have been discovered here, support the idea that the humid and well forested areas of the Terai and Bhabar provide an exclusive corridor of suitable habitat for the spread of reptiles from the aforestated areas in the east, deep into the Gangetic plains area. Faizabad, like Katernia Ghat, is situated on the banks of the Ghagra river, and the occurrence of certain species at Faizabad could be attributed to fortuitous dispersal by means of drift-wood along rivers (Smith, 1943) or simply due to closer study of the area. The actual dispersal of these species may have been through the Himalayan range, as geologically these are more ancient than the Gangetic plains. Finally it may be in order to add that in recent times it is likely that there has been extensive disruption of the distribution of herpetofauna as a result of clear-felling of large tracts of Terai forests on the plains of Nepal. But forest areas of Northern U.P. may still reveal the presence of many species hitherto believed to be restricted to the eastern parts of the country and merit intensive herpetological surveys to gain a proper perspective of the distribution of Indian herpetofauna before many species disappear without a trace.

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TABLE 1

| | Species | Distribution |
|---|---|---|
| 1. | *Enhydris enhydris* | N.E. India, Assam, Indo-China, Malay Peninsula, United Provinces (Smith). Chitwan, Nepal (Fleming & Fleming). |
| 2. | *Xenochrophis cerasogaster* | Bengal, Assam, U.P.(Faizabad), (Smith). |
| 3. | *Atretium schistosum* | Sri Lanka, India (Annamalais, Wynaad, Mysore, U.P., Orissa) (Smith). |
| 4. | *Sybinophis saggittarius* | North-eastern India from the Central and United Provinces to Eastern Bengal (Smith). Western Himalayas (Wall; in Smith). |
| 5. | *Chrysopelea ornata* | Indo-Chinese region extending to Darjeeling district and to Patna, Buxar in Bihar and Orissa in the Northwest (Smith). Western Ghats, south of Goa (Whitaker), Dangs (Lokeswara Rao). Katernia Ghat (present paper). |
| 6. | *Dendrelaphis tristis* | Sri Lanka and peninsular India as far as Sind in the Northwest and Darjeeling in the northeast (Smith)...The Ganges valley appears to be outside its limits except at the eastern part near the Delta (Wall, in Smith). Katernia Ghat (Basu-unpublished observations). |
| 7. | *Liopeltis calamaria* | Sri Lanka, the Western Ghats, Tinnevelly hills, Mysore plateau, United Provinces (Melghat, Almora District, Kurkhana, Gonda District) (Smith). |
| 8. | *Lycodon jara* | Ganjam in the northern part of the Madras Presidency, the eastern Himalayas as far west as long. 80° E, Bengal, Assam (Smith). U.P. (Whitaker-loc. Katernia Ghat). (Basu, unpublished observation). |
| 9. | *Elachistodon westermanni* | North bengal, Bihar, Purneah (Smith). Chitwan, Nepal (Fleming & Fleming). |
| 10. | *Bungarus fasciatus* | The whole of the Indo-Chinese subregion, the Malay Peninsula and Archipelago, Southern China (Smith). Hyderabad (Kinnear, in Smith), Godavari and Mahanadi valleys, Bihar, Orissa, (Wall, in Smith). Oudh in the United Provinces (Stone, in Smith). Katernia Ghat (Basu, unpublished observation). |
| 11. | *Bungarus walli* | U.P. (Faizabad), Bengal (Midnapore), Bihar & Orissa (Purnea, Gaya) (Wall, in Smith). |
| 12. | *Naja naja kaouthia* | Bengal and the eastern Himalyas as far west as Nepal, the whole of Indo-China. The specimens found in the United Provinces and Bihar are possibly migrants from the Eastern Himalayas (Smith). |
| 13. | *Ophiophagus hannah* | Peninsular India to the Himalyas, the whole of Indo-China, Burma, S. China, Malay Peninsula and archipelago, Philippine Islands, In peninsular India, its distribution corresponds to the mountain ranges and their vicinity (Smith). "This cobra is a forest snake in Nepal but not necessarily found in the hills" (Fleming & Fleming). |

May 6, 1988. D. BASU

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## 23. MELANISTIC FORM OF THE ROYAL SNAKE (*SPALEROSPHIS DIADEMA* SCHLEGEL)

(*With a photograph*)

Photo . Whiskered Black Royal Snake.

During the month of April 1988. I had seen a black coloured snake with artificial whiskers in a snake-charmer show at the Vadodara City. It was a melanistic form of the Royal Snake *Spalerosphis diadema* (Schlegel). After the show I inquired of the snake-charmer Mr. Gabbarnath Lalvadi about the snake. Apparently he had got the black snake from a snake-charmer of Maharashtra State. (Most of the snake-charmers do not have the skill to catch snakes and are supplied the snakes by the few who do have the skill). The long horsehair is implanted in the head region of the snake.

The display of a live whiskered snake earns more money for the Snake charmer.

**Measurements:** Total body length 168 cm; Tail 37 cm; Supralabials 10, a preocular and a series of subocular separating the labialas from the eye, Postocular 2; Temporals 3 + 2; Lower labials 12, 6th is smaller than others; Pair of internasal present; Loreal 2; Body scale 29 rows (29:29:24), scale keeled, outermost five rows both side are smooth; Ventrals 274; Caudals 120; Anal plate 2; Sex male.

I had also seen a black Royal Snake five years ago with one of my friends, Dr. Hasit Vaidya, who purchased the snake from a snake-charmer at Ahmedabad, which was received from North Gujarat.

The species of *S. diadema* has two subspecies or colour forms (1) *S. d. diadema* and (2) *S. d. atriceps*. Also a melanistic form has been reported (Daniel 1983). Could the melanistic form of *S. diadema* be a rare third subspecies?

July 14, 1988. RAJU VYAS

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## 24. RECORD OF *SYNEGIA* SP. (LEPIDOPTERA : GEOMETRIDAE) INFESTING BLACK PEPPER (*PIPER NIGRUM* L.)[1]

Over twenty species of insect pests have been recorded on black pepper (*Piper nigrum* L.) in India (Pillai 1978). During 1984-'86 caterpillars of *Synegia* sp. (Lepidoptera : Geometridae) were observed to damage spikes and foliage of black pepper vines at Peruvannamuzhi (Calicut district, Kerala). Preliminary observations on its biology and nature and extent of damage are reported here. The present report is the first record of the pest on black pepper.

**Biology:** Newly hatched caterpillars measured 2.5 x 0.5 mm and were pale green with a light brown band running longitudinally on the lateral and dorsal aspects. Fully grown caterpillars measured 35.9 x

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[1] Contribution number 71 of National Research Centre for Spices, Calicut 673 012.

4.0 mm and were pale green with faint brownish markings. The early instars were very active and moved quickly when disturbed, whereas the later instars were sluggish in their movements. The larval period lasted for a mean of 13.3 days (range 12-14 days under laboratory conditions. Pupation occurred in a cocoon spun with silken threads. Nascent pupae were pale green but soon sclerotised to a dark brown shade. The pupae measured 13.0 x 5.5 mm and pupal period lasted for a mean of 8.7 days (range 7-10 days). Adults were medium sized with a wing span of 37.0 mm. Both fore and hind wings were pale yellow with many vertical lines; the outer margin of the fore wing had a number of faint black spots.

**Nature and extent of damage:** The caterpillars fed on newly emerging shoots, flowering spikes and tender leaves. The feeding activity of the caterpillars on the spikes resulted in black patches on them; in severe cases of infestation, a major portion of the spike dried up completely. Tender leaves were severely damaged and the early instars fed on very tender leaves whereas the later instars fed mostly on slightly older leaves. The caterpillars generally fed from the leaf margins and in severe cases of infestation the entire leaf except the petiole was eaten away.

The pest was observed in the plantations during June- December and infestation on the foliage was more common on younger vines (2-3 years old). In a sample survey carried out during October 1984 on 100 young vines, the percentage of damaged leaves was 51.7 (range 8.0 - 92.0 per cent) and 50.7 per cent of the damaged leaves had over 30.0 per cent of the leaf area eaten away. In a similar survey carried out on 50 adult vines, 17.4 per cent of the spikes were damaged.

We are thankful to Dr. J.D. Bradley, Commonwealth Institute of Entomology, London for identifying the insect.

T. PREMKUMAR
August 7, 1987. S. DEVASAHAYAM

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## 25. *ERYTHMELUS HELOPELTIDIS* GAHAN (HYMENOPTERA : MYMARIDAE) A NEW EGG PARASITE OF *HELOPELTIS ANTONII* SIGNORET ON CASHEW[1]

The tea mosquito bug *(Helopeltis antonii* Signoret) (Heteroptera : Miridae) is one of the serious pests of cashew *(Anacardium occidentale* L.) in India. Surveys were conducted during 1982-83 in cashew plantations at Shantigodu (South Kanara district, Karnataka) on natural enemies of *H. antonii.* A single specimen of hymenopteran egg parasite *Erythmelus helopeltidis* Gahan (Mymaridae) was obtained during March, 1983. *E. helopeltidis* has earlier been recorded on *H. cinchonae* in Malaysia; the parasite was also found to oviposit and develop in eggs of *H.bradyi* (Lever 1949). The present report appears to be the first record of the parasite on *H. antonii.*

I am thankful to Dr. T.C. Narendran, Department of Zoology, University of Calicut, Kerala for identifying the parasite.

March 5, 1987. S. DEVASAHAYAM

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[1] Contribution No. 491 of Central Plantation Crops Research Institute, Kasargod - 670 124, Kerala.

# 26. STUDIES ON *COELOPHORA BISELLATA* MULS. (COLEOPTERA : COCCINELLIDAE)

## 1. FIELD RECOGNITION OF DIFFERENT LARVAL INSTARS AND THE TRAITS OF PUPAE AND ADULTS

*(With nine text-figures)*

### INTRODUCTION

*Coelophora bisellata* Mulsant was originally described by Mulsant in 1850 from Bengal and Java. In 1910 Sicard described, from India, the variate *nudipennis* of *C. bisellata*. The occurrence of *C. bisellata* from various regions of Indian subcontinent has been reported since then but nothing is known about the biology of this insect. As studies on the predators, parasites and pathogens of the aphids are required for the effective biological control of the pests, the present investigation was undertaken to throw light on the bioecology of this ladybird beetle.

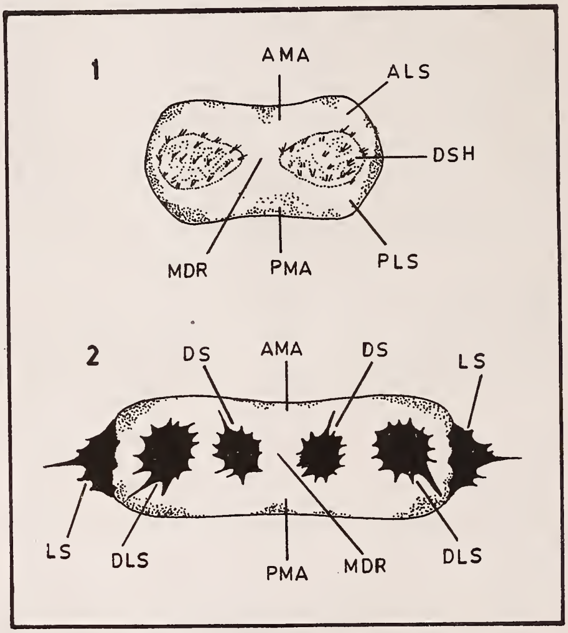
### MATERIAL AND METHODS

The adult ladybird beetles, *C. bisellata* were collected from the wild and were reared in the laboratory in transparent plastic containers of 7 cm diameter and 3 cm height with enough pores on the lid for aeration.

The larvae were reared from the eggs laid by the gravid females. The measurements of the eggs, larvae, pupae and adults were determined using stage and ocular micrometer. The colour patterns of the larval instars, with the help of which one can recognise them in the field, are described in this paper. The larval colour patterns are used generally to identify the species without killing them, since these colour patterns are instar and species specific (Storch 1970, Miszczak 1974).

On the dorsal region of mesothorax and metathorax of the larvae a pair of dorsal shields are found, namely *mesosh* and *metash* (Storch 1970) (Figure 1). The different regions of the setal areas in an abdominal segment are shown in figure 2. The first eight abdominal segments have distinct setal areas arranged in a similar manner. Each tergum bears six setal areas, the dorsal setal area (DS), nearer to the dorsal mid-line, dorso- lateral setal area (DLS), lateral to the dorsal setae, and lateral setal area (LS), lateral to the dorso-lateral setae.

It has been observed that the colour is presumably due to deposition of metabolic by-product in the fat body or epidermis, which are visible through the transparent cuticle (Storch 1970).



Figs. 1-2. *Coelophora bisellata* Mulsant

Larval segments showing the setal areas described in the text.

1. A thoracic segment; 2. An abdominal segment.

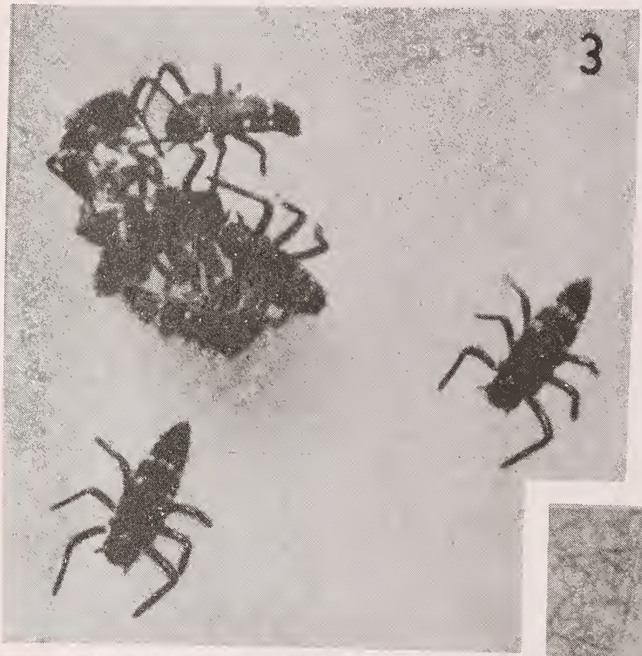
*Abbreviations*: ALS - Anterolateral side; AMA Anterior marginal area; DLS - Dorsolateral setae; DS - Dorsal setae; DSH - Dorsal shield; LS - Lateral setae; MDR - Mid dorsal region; PLS - Postero lateral side; PMA - Posterior marginal area.

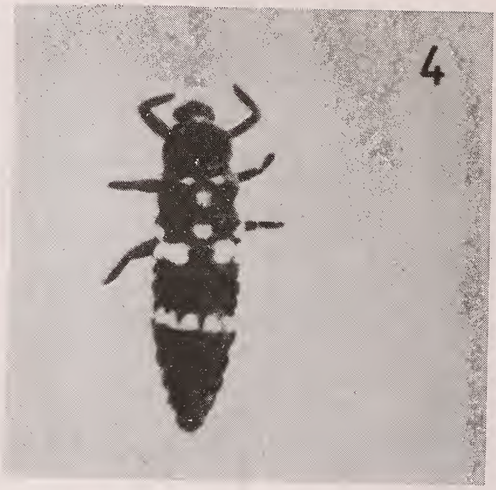
### OBSERVATIONS

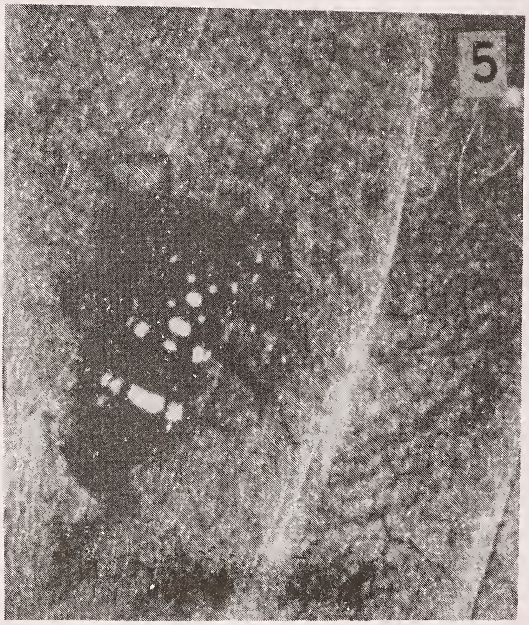
1. **Eggs:** Pale yellow, with smooth and shiny surface. Average length and breadth of 20 eggs 1.10 ± 0.06 mm and 0.58 ± 0.02mm respectively. Free end more blunt and the posterior end tapering and attached to the substratum. The number of eggs in each batch ranges from 1 to 19 (Fig. 9), the average being 7.58 ± 3.26. Average number of eggs/female is 325.83 ± 85.86, the range being 171 to 561 in 24 females observed.
2. **Larvae:** The key for the identification of different larval instars has been given in Table 1 (Figs. 3 to 6).

THE KEY FOR THE IDENTIFICATION OF DIFFERENT LARVAL INSTARS OF *Coelophoroa bisellata* IN THE FIELD

| Traits | I Instar | II Instar | III Instar | IV Instar |
|---|---|---|---|---|
| Colour | Freshly emerged ones are grey first and turn black after one or two hours. | As in first instar | As in first instar | As in first instar |
| Length x Breadth (mm.) | 1.70 ± 0.05 x 0.41 ± 0.03 | 2.81 ± 0.14 x 0.63 ± 0.08 | 5.82 ± 0.11 x 1.33 ± 0.05 | 11.24 ± 0.15 x 2.16 ± 0.23 |
| Prothorax | —— | —— | —— | The peripheral area is grey. |
| Mesothorax | —— | Three pale white spots on the dorsal side, of which two are anterior and one is posterior. | Has three white spots on dorsal region, of which the posterior one is larger than the anterior ones. The anterolateral and posterolateral regions, on each side, have white spots. | Three white spots as in instar III; pale mid-dorsal line also develops. |
| Methorax | — | Has on the mid-posterior marginal area a white spot. Lateral setal area on each side is white. | Has three white spots on the dorsal region, of which the posterior one is larger than the two anterior spots; the antero lateral and posterolateral regions, on each side, have white spots. | Three white spots as in instar III; pale mid dorsal line also develops. |
| Abdominal Segment I | The dorso lateral and lateral setal areas, on each side, are white. | Dorso-lateral and lateral setal areas are white in colour, on each side. | Dorso-lateral and lateral setal areas are white in colour, on each side. As the larva grows, the mid-dorsal region-develops a pale white patch. | Dorso-lateral and lateral setal areas are white. The mid-dorsal region between the dorsal setae is white. |
| Abdominal Segment II | —— | —— | —— | A pale white mid dorsal spot develops. |
| Abdominal Segment IV | The setal areas of dorsal, dorsolateral and lateral sides are pale white. | Dorsal, dorsolateral and lateral setal areas are white. | Dorsal, dorsolateral and lateral setal areas are white. | Dorsal, dorsolateral and lateral setal areas are white. |
| Abdominal Segment V | —— | —— | The lateral setal area, on each side, is white. | Lateral setal area, on each side, is white. |
| Abdominal Segment VII | —— | —— | The posterial marginal area has a single white line, broken to form three segements. | The posterior marginal area has a single white line. |
| Abdominal Segment VIII | —— | —— | —— | A pale white posterior marginal line in the grown up larvae. |







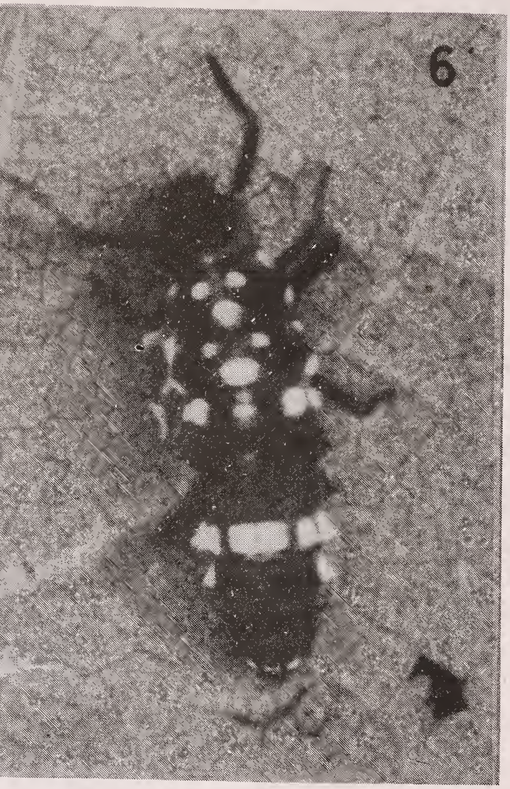
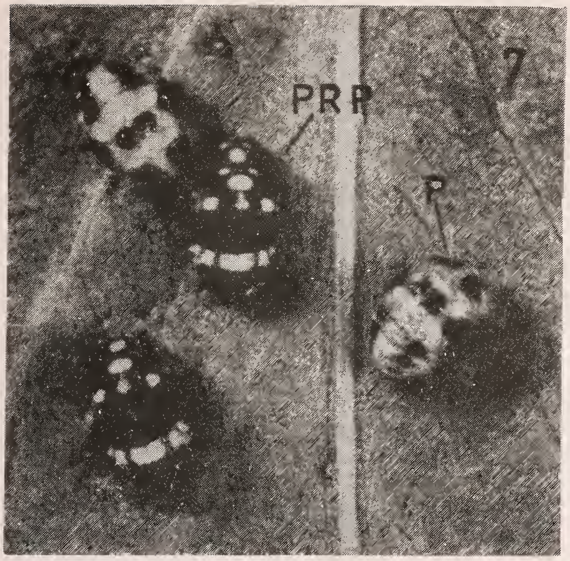
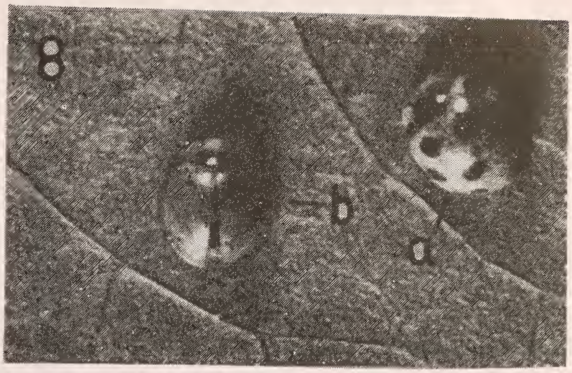


Fig. 3. The newly hatched I instar larvae, many of them clinging to the egg shells.
Fig. 4. II instar larva. Fig. 5. III instar larva. Fig. 6. IV instar larva.

3. **Pupa:** Pale yellow to deep yellow and not protected by larval skin (Fig. 7). The anal end of the pupa is covered by larval exuvium. Pronotum with two large spots, mesonotum without any spots. Metanotum with two large black spots dorsally. The subhumeral and basal areas are





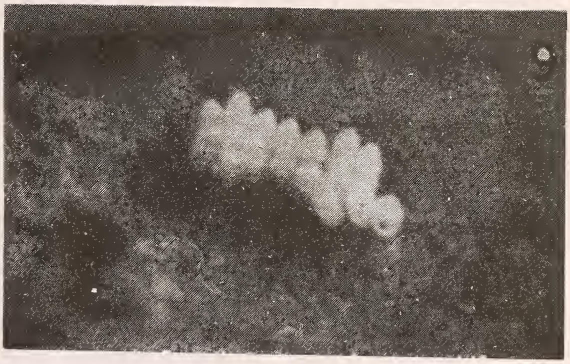


Fig. 7. **Prepupae (PRP) and pupae (P).**

Fig. 8. Adult beetles.

a. *C. bisellata* Mulsant nominate form. b. *C. bisellata* Muls. var. *nudipennis* Sicard.

Fig. 9. The egg cluster.

pale and median area black. Dorsal abdominal region with six large black spots. Pupae are often seen attached to the undersurface of the leaves, avoiding exposure to light and enemies. The average maximum length and breadth of the pupa are 5.80 ± 0.13 mm and 3.94 ± 0.21 mm respectively.

4. **Adult:** The pronotum has four black spots, of which the lateral ones are smaller. Each elytron has six spots, of which two are sutural (Fig. 8). The pronotal and elytral spots show intraspecific variations (Kapur 1959). In freshly emerged beetle, the ground colour of elytra is pale yellow. With increasing age, it changes from pale yellow through deep yellow to orange. The nominate form with all the spots (Fig. 8a) is abundant throughout the year and the variate *nudipennis* Sic., in which the elytral spots are altogether absent (Fig. 8b), occurs predominantly during summer.

ACKNOWLEDGEMENT

Thanks are due to Dr. T.G. Vazirani, of Commonwealth Institute of Entomology, London, for the help in the identification of the beetle.

February 27, 1987 M. RHAMHALINGHAN

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## 27. HITHERTO UNRECORDED PLANT FROM UPPER GANGETIC PLAIN WITH ITS ETHNOBOTANICAL USES

(*With a text-figure*)

During the survey of Flora of Basti district in Uttar Pradesh which is very close to Nepal territory with the geographical limits of 26° 30' and 27° 30' North latitude, 82° 12' and 83° 50' East longitude, the senior author collected an interesting plant from the area, which was later identified as *Aeschynomene americana* L.

The genus *Aeschynomene* L. is represented by 30 species, distributed in tropics of both the hemispheres. In India, only two species were reported till the middle of this century from the plains upto 1650 m in Himalaya (Hooker 1885). But Chatterjee (1960) and Maheshwari and Ghosh (1971) have added one more species which is indigenous to tropical America, i.e. *Aeschynomene americana* L. from Hazaribagh and Ranchi districts in Bihar. After a decade an additional locality has been reported by Mohanan (1981) from Quilon district of Kerala.

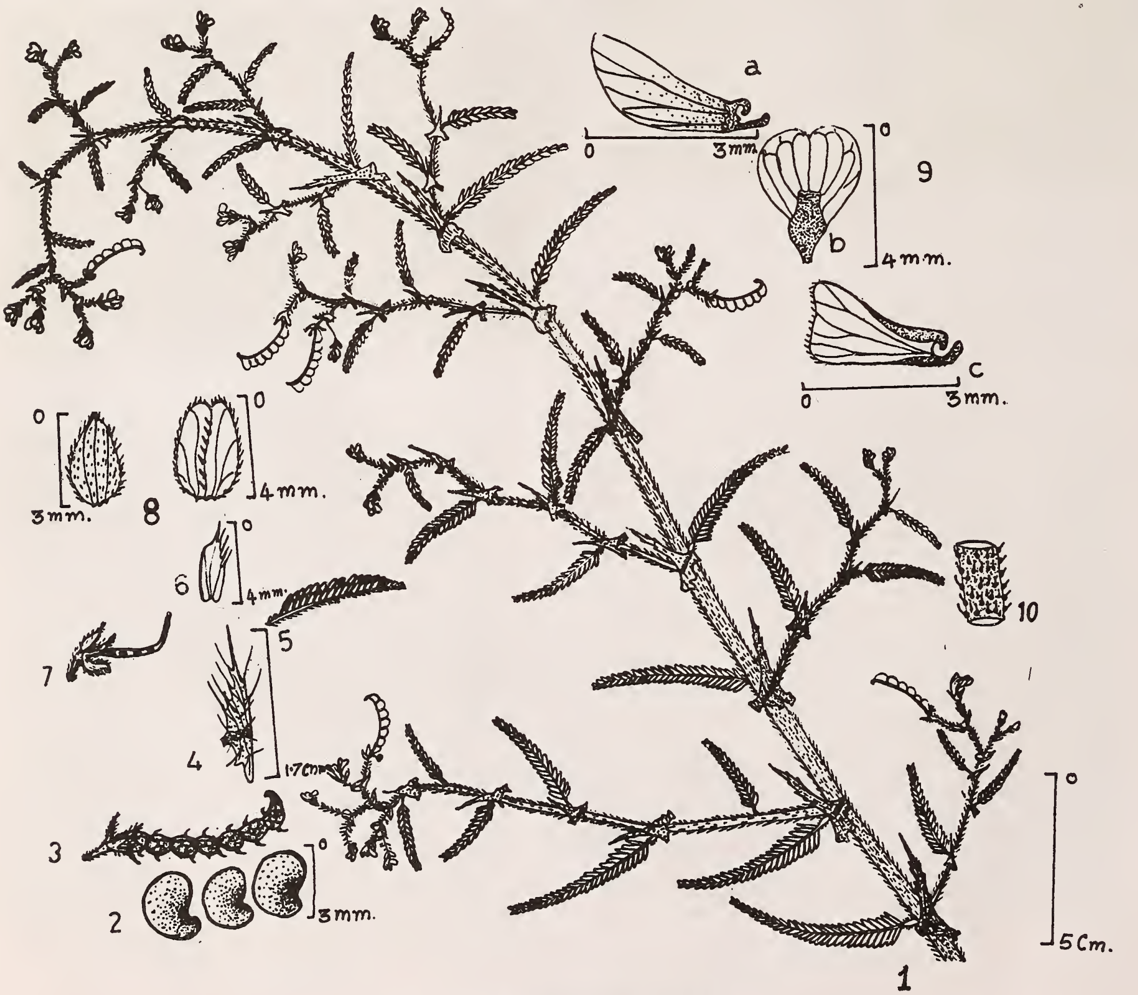

Fig. 1. Aeschynomene americana L.

1. Habit; 2. Seeds; 3. Fruit; 4. Stipule; 5. Leaf; 6. Leaflet; 7. Gynoecium; 8. Sepals; 9. Petals – a. keel; b: standard; c. wing; 10. Enlarged portion of stem, showing swollen based glandular hairs.

**Aeschynomene americana** L. Sp. Pl. 713. 1753; Chatterjee, Sci. & Cult. 25 : 488-1960. *A. mexicana* Birali ex Calla, Herb. Podem. 2 : 195. 1834. (Fig. 1).

An erect or decumbent, glandular-hispid to subglabrous annual herb with purple flower, frequently found in marshy places along ponds and lakes in association with *Aeschynomene aspera* L., *Cyperus imbricatus* Retz., *Eleocharis palustris* R. Br., *Hydrolea zeylanica* Vahl and *Melochia chorchorifolia* L.

Fls. & Frts.: August - January; Sohratgarh (Naugarh); D.C. Saini, 5899.

Uses : The leaves and tender branches are cooked and eaten as vegetable. The small pieces of stem are used as fishing-floats.

ACKNOWLEDGEMENTS

We thank Prof. S.N. Mathur, Head, Botany Department, Gorakhpur University, Gorakhpur, for providing laboratory and library facilities during the course of the study. Thanks are also to Dr. J.K. Maheshwari, Deputy Director, National Botanical Research Institute, Lucknow, for confirming the identity of specimens.

D. C. SAINI
S. K. SINGH
SURESH SINGH

July 7, 1988

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## 28. *ALTERNANTHERA PHILOXEROIDES* (MART.) GRISEB. - A NEW RECORD FOR NORTH-WESTERN HIMALAYA

(*With a text-figure*)

The genus *Alternanthera* Forsk. of the family Amarantaoeae comprises of about 200 species in the tropics and subtropics and is best developed in America. Some of the species have been introduced in India, Burma, Australasia and Malaysia. The genus is represented by six species in India. *Alternanthera philoxeroides* (Mart.) Griseb., a south American weed, probably Brazilian in origin, was introduced long ago in Malaysia and quite naturalized in Java. Maheshwari (1984) reported this species for the first time from India from lakes and waterpools in the eastern parts of India mainly from West Bengal and Bihar. Bennet (1979) recorded this species from Howrah district (West bengal) commonly growing in marshy ditches, sides of ponds and along water-courses, while Varma (1981) reported it from Bhagalpur (Bihar) growing frequently in ponds and ditches and Deb (1983) reported it from Agartala (Tripura) growing in stagnant or slow moving shallow ditches forming large communities. Very recently, Gupta and Murty (1986) reported it as a new record for Upper Gangetic Plain growing abundantly along the Hindal and Jamuna river.

During the course of preparation of the flora of Kumaun Himalaya, a few specimens were collected from Champhawat in Pithoragarh district growing commonly near stagnant or slow moving shallow water, ditches and marshes. After a critical study, it was identified as *Alternanthera philoxeroides* (Mart.) Griseb. A critical study and herbaria and published literatures indicate that this species has not been reported so far from mountainous regions of north-western Himalaya (Hooker 1885, Collett 1902, Duthie 1906, Gupta 1968, Singh and Kachroo 1976, Sharma and Kachroo 1981, Chowdhary and Wadhwa 1984, and Naithani 1985). Therefore, the collection of species from Kumaun is an important addition to the flora of Kumaun Himalaya in particular and the flora of north-western Himalaya in general.

The present paper provides a description of this species with illustration to facilitate easy identification. Field number along with collector's name is given in brackets. The voucher specimens are deposited in the Herbarium, Department of Botany, D.S.B. College, Kumaun University, Naini Tal.

**Alternanthera philoxeroides** (Mart.) Griseb., Abh. Ges. Wiss. Goett. 24: 36. 1879; Kunze, Rev. Gen. Pl. 2: 540. 1891; Schinz. in Engl. and Prantl, Nat. Pfam. 3. 1a: 115. 1893; Backer in Fl. Males.

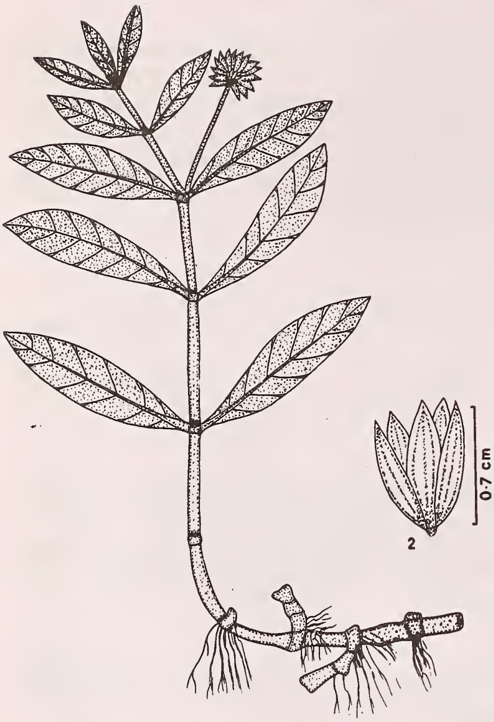

Fig. 1. *Alternanthera philoxeroides* (Mart.) Griseb.
1. Flowering plant; 2. Flower.

Ser. 1. 4(2): 93. 1949; Maheshwari, Bull. Bot. Surv. Ind. 6(2-4): 313. Figs. 1-9. 1964; Gupta & Murty, Indian J. For. 9(3): 282. 1986. *Bucholzia philoxeroides* Mart., Nova Acta Acad. Leop.- Carol. 13(1): 315. 1826. *Telanthera philoxeroides* Moquin-Tandon in DC. Prodr. 13: 362. 1849 incl. vars. *Achranthes philoxeroides* (Mart.) Standl., Journ. Wash. Acad. Sci. 5: 74. 1915.

Perennial aquatic or marshy herbs, 50-100 cm long, decumbent or ascending from a creeping and floating base, often much- branched forming dense masses. Stem simple or branched, fistular, longitudinal striated, with longitudinal hairy grooves on two opposite sides, otherwise glabrous. Leaves opposite, lanceolate, oblong to nearly obovate, acute to rounded, submucronate, base cuneate, 4-10 x 0.5-2.5 cm, entire, thin, glabrous and glabrate, with a transverse row of white, smooth hairs in the axils. Petiole 1-6 mm long. Inflorescence usually solitary axillary, pedunculate, ovoid to globular-ellipsoid, white heads, also terminal sessile. peduncles unbranched, with a longitudinal hairy groove on the adaxial side, otherwise glabrous. Flowers dense. Bracts and bracteoles subequal, 1-nerved, glabrous, white, persistent. Perianth 5 tepals, subequal, 3-4 times as long as bracts, oblong, acute, mucronate, 1-nerved. Stamens 5, united below into a tube. Pseudostaminodia distinct, lacerate exceeding the stamens. Ovary shortly stalked, turbinately globose, compressed, rounded at the apex. Stigma globose, capitate, glandular. Style short, cylindrical.

Flowering : May - Nov.

*Common name* : Alligator weed.

*Ecology* : Gregariously growing weed in stagnant or slow- moving water, pools, ditches and marshes at Champhawat around 1400 m in Pithoragarh district.

*Specimens examined* : Pithoragarh district; Champhawat (Samant 1613).

## ACKNOWLEDGEMENT

We are grateful to the Head, Department of Botany, D.S.B. College, Kumaun University, Naini Tal, for facilities and encouragements.

October 10, 1987.

Y. P. S. PANGTEY
S. S. SAMANT

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## 29. A NOTE ON THE SYNONYMY OF *HYPTIANTHERA* WT. & ARN. AND *PETUNGA* DC. WITH *HYPOBATHRUM* BL. (RUBIACEAE)

Recently Robbrecht (1980) postulated the tribe Hypobathreae near Gardenieae and coffeeae in the subfamily Pavettoideae of the family Rubiaceae. He placed in it several genera of which *Hyptianthera* wt. & Arn., *Petunga* DC. and *Morindopsis* Hook.f. occur in India. He treated *Petunga* DC. as synonymous with *Hypobathrum* Bl., as considered by Bakhuizen f. (1965).

The genera *Petunga* DC. (1830) and *Hyptianthera* Wt. & Arn. (1834) are treated as distinct by De Candolle (1830), Hooker f. (1873, 1880), Schumann (1891) and others. Workers on Indian regional floras followed them. Hooker f. (1880) further introduced the genus *Hypobathrum* Bl. in key to the genera of Rubiaceae "because it most probably occurs in the Malay Peninsula, though it is as yet unrecorded."

On study of the genera *Petunga* DC. and *Hyptianthera* Wt. & Arn., the author of the present note hesitated to recognize their generic distinction and was inclined to treat them as the same genus. On consulting literature, he was surprised to find that Kurz (1877) had more than a century ago merged *Hyptianthera* Wt. & Arn. with *Hypobathrum* Bl. and that Hook.f. (1880) and Robbrecht (1980) probably overlooked this merger as they were silent about such a treatment of the genera. Very recently Bakhuizen f. (1965) in Backer and Bakhuizen, Fl. Java. merged *Petunga* DC. with *Hypobathrum* Bl. This treatment also appears to have been overlooked by the recent Indian workers in their respective works. The present worker fully agrees with Kurz (1877), Bakhiuzen f. (1965) and Robbrecht (1980), and considers that the merger of these three genera is taxonomically justified. As they did not give a full synonymy it is worthwhile to present it here.

**Hypobathrum** Bl. Bijdr. 107. 1826; DC. Prodr. 4: 459. 1830; Miq. Fl. Ind. Bat. 2 : 236. 1861 & in Ann. Mus. Lugd. Bat. 4: 243. 1869; Kurz, For. Fl. Brit. Burma 2: 50. 1877; Hook.f. in Benth. & Hook.f. Gen. Pl. 2: 93. 1873 & Fl. Brit. Ind. 3: 19. 1880 (in key); Schumann in Eng. & Prantl, Nat. Pflanzenfam. IV. 4: 80. 1891; Robbrecht in Bull. Jard. Bot. Nat. Belg. 50: 75. 1980.

**Petunga** DC. Prodr. 4: 398. 1830; Walp. Ann. 2: 792. 1843; Miq. Fl. Ind. Bat. 2: 200. 1861 & Ann. Mus. Lugd. Bat. 4: 130 & 269. 1869; Hook.f. in Benth. & Hook.f. Gen. Pl. 2: 93. 1873 & Fl. Brit. Ind. 3: 120. 1880; Schumann in Eng. & Prantl., Nat. Pflazenfam. IV. 4: 79. 1891.

**Higinsia** Bl. Bijdr. 988. 1826, non Pers.

**Hyptianthera** Wt. & Arn. Prodr. 399. 1834; Hook.f. in Benth. & Hook.f. Gen. Pl. 2: 94. 1873 & Fl. Brit. Ind. 3: 121. 1880; Walp. Rep. 2: 518. 1843; Schumann in Eng. & Prantl., Nat. Pflazenfam. iv. 4: 80. 1891; Robbrecht in Bull. Jard. Bot. Nat. Belg. 50: 75. 1980.

Type: *H. frutescens* Bl.

Distribution: About 10 species; India, Bangladesh to Phillippine Islands; 2 species in India.

### KEY TO THE INDIAN SPECIES

Flowers in dense clusters; drupes berry-like, sessile.......... .............................. *H. strictum* (Wt. & Arn.) Kurz.
Flowers in spike like racemes; drupes berry-like, stalked..... ......................... *H. racemosum* (Roxb.) Kurz.

February 26, 1988. D. B. DEB

## 30. AN ENUMERATION OF FERN-ALLIES OF NAINI TAL (WESTERN HIMALAYA)

Duthie (1906) was the first to catalogue the ferns and fern- allies of Kumaun and adjacent portions of Garhwal and Tibet based on the collections made by Strachey and Winterbottom during the years 1846-1849 covering a total area of 18,400 sq kms. From this vast area, a total of 13 species belonging to 4 genera of fern- allies were recorded. Out of 13 species of fern-allies, 3 species namely *Selaqinella chrysocaulos* (Hook. et Grev.) Spring, *S. pallidissima* Spring and *Equisetum diffusum* D.Don were reported from Naini Tal. Since then, no further work on the fern-allies of Naini Tal has been carried out so far.

Although the fern flora of Naini Tal is very well explored by a number of workers none of them have studied the fern-allies of Naini Tal. In order to fill up this lacuna, the present study was initiated to collect and study the fern-allies of Naini Tal and its adjacent areas, covering an altitudinal range from 900- 2611 m during the last three years. In all, 3 genera and 7 species belonging to 3 families were collected from Naini Tal and its adjacent portions. These species were identified with the help of available literature and later all the species of *Selaginella* P. Beauv. were confirmed by Dr. R.D. Dixit, Regional Botanist, Botanical Survey of India (Central Circle), Allahabad.

The present paper enumerates the fern-allies of Naini Tal along with other relevant information. Field number of each species is given in brackets and voucher specimens are deposited in the Herbarium, Department of Botany, DSB College, Kumaun University, Naini Tal.

### ENUMERATION

#### Family : HUPERZIACEAE

**Huperzia pulcherrima** (Wall. ex Hook. et Grev.) Sen et Sen, Fern Gaz. 11(6): 419.f. 2i-r. 1978; Dixit, Census Indian Pterid. 8. 1984. *Lycopodium pulcherrimum* Wall. ex Hook. et Grev., Icon. Fil. t. 58. 1831. *L. setaceum* Buch.-Ham. ex D. Don var. *subulifolium* Wall. apud Clarke, Trans. Linn. Soc. Lond. 2(Bot.) 1: 590.1880. *L. gramineum* Spring, Monog. Lycopod. 2: 19. 1848.

Ecology: Rare but locally frequent between 1,300-1,400 m and grows both lithophytically and epiphytically in shady, moist ravines near Bajoon (YPSP 105).

Distribution: North-west Himalayas, Eastern India, Nepal, Bhutan and China.

#### Family : SELAGINELLACEAE

**Selaginella chrysocaulos** (Hook. et Grev.) Spring, Bull Acad. Brux. 10 : 232. 1843. Duthie, Cat. Pl. Kumaun 232. 1906; Dixit, Census Indian Pterid. 12. 1984. *Lycopodium chrysocaulos* Hook. et Grev. in Hook. Bot. Misc. 2: 401. 1831. *Selaginella philippina* var. *khasiensis* Bak., Journ. Bot. 22 : 298. 1884.

Ecology: Very common throughout the area between 900-2,500 m and grows in open as well as moist-shady places (YPSP 415, 243).

Distribution: Himachal Pradesh, Uttar Pradesh, Sikkim, Arunanchal Pradesh, Nagaland, Manipur, Meghalaya, Kerala, Nepal and Bhutan.

**S. involvens** (Sw.) Spring, Bull. Acad. brux. 10 : 136. 1843, emend. Hieron., Hedw. 50 : 2. 1911; Dixit, Census Indian Pterid. 14. 1984. *Lycopodium involvens* Sw., Syn. Fil. 182. 1806. *Selaginella caulescens* (Wall. ex Hook. et Grev.) Spring, Bull. Acad. brux. 10 : 137. 1843; Duthie, Cat. Pl. Kumaun 232. 1906.

Ecology: Frequent throughout the area between 900-1,300 m and grows on moss-laiden wet and moist rocks. The branches get involutely rolled up during dry period (YPSP 73, 341, 558).

Distribution: Throughout India in mountainous regions except in the northern part, Nepal, Bhutan, Burma, Sri Lanka, Indo-China, Malaysian Islands.

**S. pallidissima** Spring, Bull. Acad. Brux. 10: 231. 1943; Duthie, Cat. Pl.Kumaun 232. 1906; Dixit, Census Indian Pterid. 15. 1984.

*S. integerrima* sensu Strachey in Gaz. North-West Prov. 66. 1882 (non Spring 1850)

Ecology: Quite frequent around Naini Tal above 2,000 m and grows on moss-laiden wet rocks, under the shade of large boulders and even on man-made cemented walls (YPSP 306).

Distribution: Himachal Pradesh, Uttar Pradesh and Arunachal Pradesh.

**S. subdiaphana** (Wall. ex Hook. et Grev.) Spring, Bull. Acad. Brux. 10 : 232. 1843; Dixit, Census Indian Pterid. 17. 1984. *Lycopodium subdiaphanm* Wall. ex Hook. et Grev. in Hook. Bot. Misc. 2 : 401. 1831.

Ecology: Very common between 900-1,400 m throughout the area and grows on wet rocks and walls along roadsides and forest margins (YPSP 396).

Distribution: Punjab, Himachal Pradesh, Uttar Pradesh, Meghalaya, Nagaland and Nepal.

#### Family: EQUISETACEAE

**Equisetum diffusum** D. Don, prodr. Fl. Nepal 19. 1825; Clarke, Trans. Linn. Soc. Lond. 2(Bot.) 1 : 594. 1880; Duthie, Cat. Pl. Kumaun 246. 1906; Dixit, Census Indian Pterid. 19. 1984.

Ecology: Quite common between 900-1,700 m and grows luxuriantly near sandy situations along the banks of streams, rivers and marshy localities (YPSP 412, 455).

Distribution: Himachal Pradesh to Kumaun, Sikkim, Assam, Meghalaya, Nepal, Bhutan, Burma and China.

**E. ramosisimum** Desf. subsp. *debile* (Roxb. ex Vauch.) Hauke, Amer. Fern Journ. 52: 33. 1962; Dixit, Census Indian Pterid. 20. 1984. *E. debile* Roxb. ex Vauch., Mon. Preles 387. 1821; Clarke, Trans. Linn. Soc. Lond. 2(Bot.) 1 : 594. 1880; Duthie, Cat. Pl. Kumaun 246. 1906.

Ecology; Rare and grows gregariously on sandy soils and marshy localities around 900 m near Bhujia Ghat (YPSP 429, 430).

Distribution: India (throughout the mountainous regions), Nepal, Burma, South-China, Formosa, Hainan, Indo-China, Philippines, Indonesia, New Guinea, New Hebrides, New Caledonia and Fiji.

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Y. P. S. PANGTEY
S. S. SAMANT

June 10, 1987.

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# THE USE OF GEOGRAPHIC INFORMATION SYSTEMS IN IDENTIFYING POTENTIAL WILDLIFE HABITAT[1]

SEJAL WORAH[2], E.K. BHARUCHA[3] AND W.A. RODGERS[4]

(*With 6 plates*)

The possibilities of using a Geographic Information System and Systematic Reconnaissance Flight in wildlife conservation is discussed. Potential habitats for four key wildlife species of the Dangs District have been identified using these techniques. The model is based on five habitat parameters which were assessed during the SRF. Analysis of this data was carried out using the GIS software ARC/INFO and results obtained in the form of grid maps showing habitat suitability.

## INTRODUCTION

This paper discusses how a Geographic Information System (GIS) and Systematic Reconnaissance Flight (SRF) can be used to predict locations of potential habitat for wildlife. The technique can be especially useful in large areas where it is not possible to carry out intensive field studies over the entire area due to constraints of time or funds. In this case, the study area is the Dangs District in South Gujarat, an area of approximately 1800 sq.km (Fig. 1). Potential habitats for four key species, namely Tiger (*Panthera tigris*), Spotted Deer (*Axis axis*), Rustyspotted Cat (*Felis rubiginosa*) and Giant Squirrel (*Ratufa indica dealbatus*) have been mapped. Each of these species is extremely rare in the Dangs and, in fact, the giant squirrel is known only from past reports (Appendix I). The main purpose of this paper, however, is not to identify actual habitats of these species, but to demonstrate how GIS and SRF can be used as tools in wildlife conservation.

## GEOGRAPHIC INFORMATION SYSTEMS

A GIS is usually a computer based system used for storing,manipulating and analysing large volumes of spatial data. The geographic database can be stored in the form of thematic maps and related attributes such as site data, topographic data, land use types and linear structures. These data can then be retrieved as required, manipulated, overlaid and presented in a map or table form for a specific purpose.

One of the important functions of a GIS is to allow the results of data processing for intensive test areas to be transferred over the entire study area. In this way, the characteristics of the entire study area can be mapped in one form in one databank which can be easily manipulated for later computer modelling (Haber & Schaller 1988).

However, in this particular case, a different approach was used. Information on the habitat requirements of the target species was obtained both from literature and from actual field surveys carried out in the Dangs. The data obtained was used to prepare models of the possible distribution of the Tiger, Spotted Deer, Rustyspotted Cat and Giant Squirrel. These models can later be checked in the field and updated as required. The GIS thus provides some basic guidelines on where the species are likely to occur, and identifies areas where specific management to protect their habitat is likely to provide maximum conservation gains.

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## METHODOLOGY

The study was carried out in two main phases:
1. An aerial survey was carried out over the entire study area. Sixteen parallel north–south transects were flown over the study area at an altitude of 300 m above the highest point on each transect. (However, due to operational difficulties and the hilly nature of the terrain, transects 6, 8 and 9 could not be completed. These gaps in the information can be filled in by ground checking). Visual observations on key habitat parameters were recorded continuously along the length of each transect on a proforma. These observations were divided into 30 second subunits. The information collected in this manner was then transferred onto a series of grid maps of the Dangs wherein each grid cell corresponded to one subunit. The size of the grid cells was calculated based on the speed of the aircraft and elapsed time. Each grid cell corresponds to approximately 4.5 sq.km. Since a relatively simple and coarse grained system based on systematic grid square sampling was used, it necessitated the use of major habitat variables only. We used two physical variables: topography and degree of dissection; two vegetation variables: vegetation type and cover values, and the pattern and intensity of land use. Water is not a limiting factor in the Dangs. We believe these variables can present an adequate overview of large mammal habitat.
2. The information from these maps was later entered into a database file and models were built to demonstrate habitat requirements for each of the species. These models were based on the five habitat variables that were recorded during the flight. The habitat requirements were based on actual sightings of the species, reports from the area and information obtained from literature.

The GIS software ARC/INFO (ESRI-California 1983) was used to process this data. First a grid of the required size and structure was generated. The information from the database file was then superimposed onto this grid and coded to obtain a set of maps showing the various habitat parameters. The constraints for habitat requirements for each species were entered in the required format and four maps showing the potential habitats for each species were generated. Finally, by overlaying these four maps, a single map showing the combined habitat requirements for all four species was obtained.

## RESULTS

Figs. 2-5 show the classification of the different habitat parameters as recorded during the aerial survey. Fig. 2 shows topographical features which are classified into five categories, namely, ridge, slope, plain, valley and catena. (A feature was classified as a catena when it consisted of a combination of features which could not be classed into any one category). Fig. 3 depicts the degree of slope of each of these features and is classified into flat, gentle, undulating, steep or precipitous slopes. Fig. 4 shows the amount of vegetation cover and is divided into three percentage classes, 1-30%, 31-70% and > 70%. Fig.5 shows vegetation type, which has been simplified into five classes. These are:

Forest:Most of the area covered by natural forest or old plantation which cannot be differentiated from a forest from the air.

Permanent (P) Field: Fields with regular, distinguishable boundaries and few lopped trees within them.

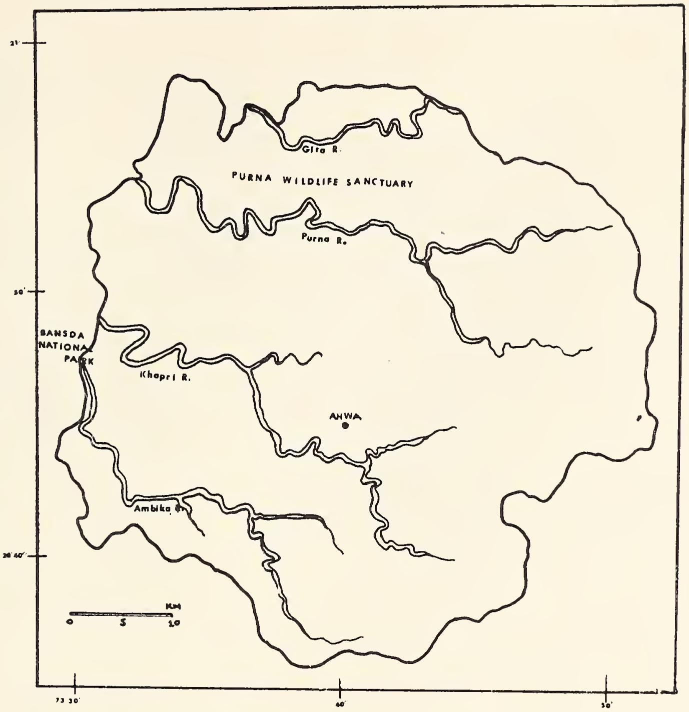
Temporary (T) Field: Fields with no distinguishable boundaries and with several lopped trees within them.

Forest/Agriculture: Part of the area under forest cover and part of it under P. or T. Fields.

Plantation: Teak or bamboo or mixed plantation, usually quite young.

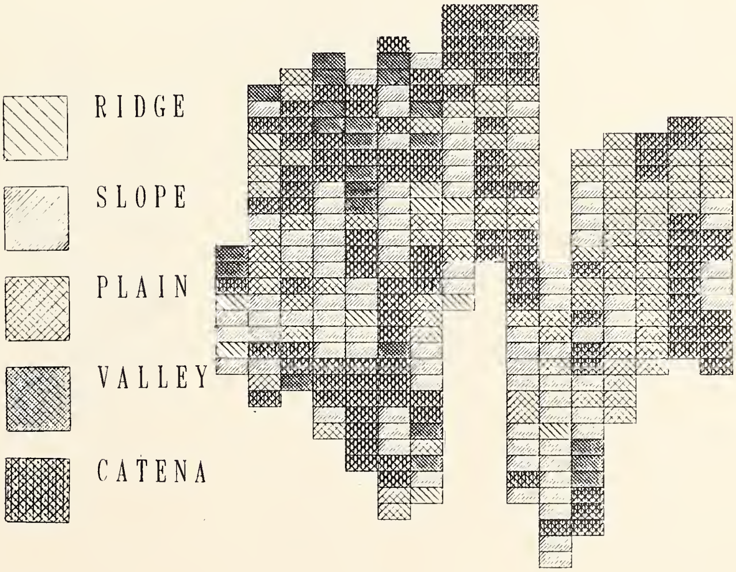
Fig. 6 shows the intensity of agriculture, which has been divided into four percentage classes, 0%, 1-30%, 31-60% and > 60%. The models for the habitat requirements for the four species are based on combinations of these 22 habitat variables and are summarised in Table 1. A high and medium quality combination is used for each species.

For instance, for the tiger, high quality habitat must have the following characteristics: topography can be either a ridge, slope, plain, valley or catena; the slope should be flat, gentle or undulating; cover should be > 70%; vegetation should be forest, and agriculture 0% For medium quality tiger habitat, the

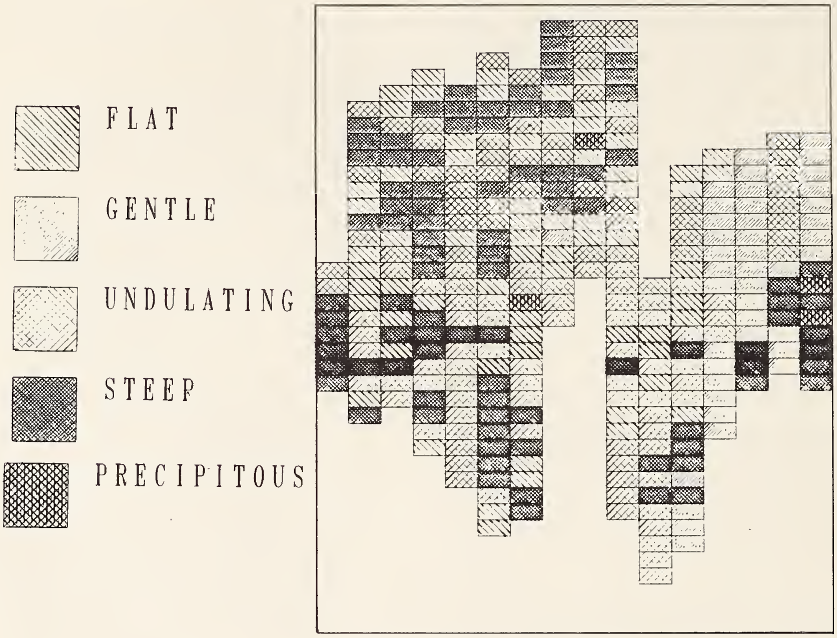

Gira R.
PURNA WILDLIFE SANCTUARY
Purna R.
BANSDA NATIONAL PARK
Khapri R.
AHWA
Ambika R.
KM
0
5
10
21°
50'
20°40'
73°30'
40'
50'

THE DANGS — showing locations of Purna Wildlife Sanctuary & Bansda National Park.

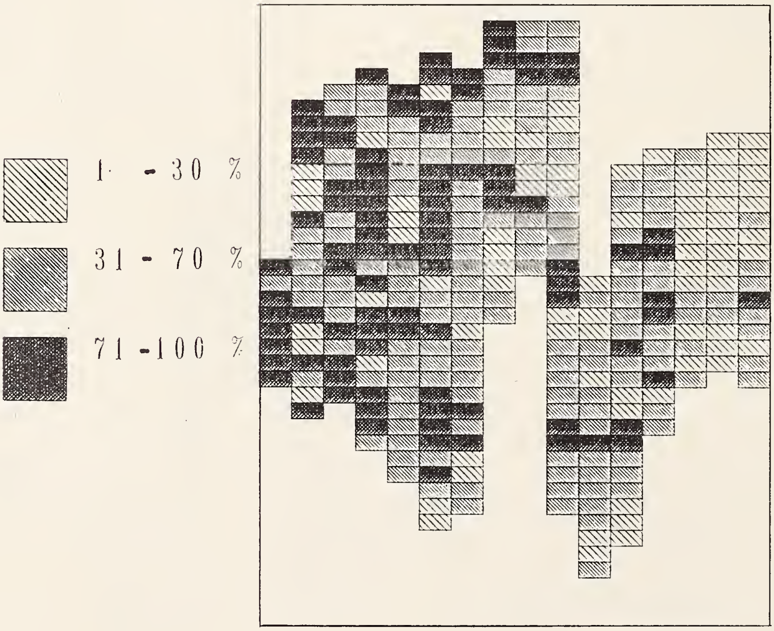
TOPOGRAPHY


RIDGE
SLOPE
PLAIN
VALLEY
CATENA

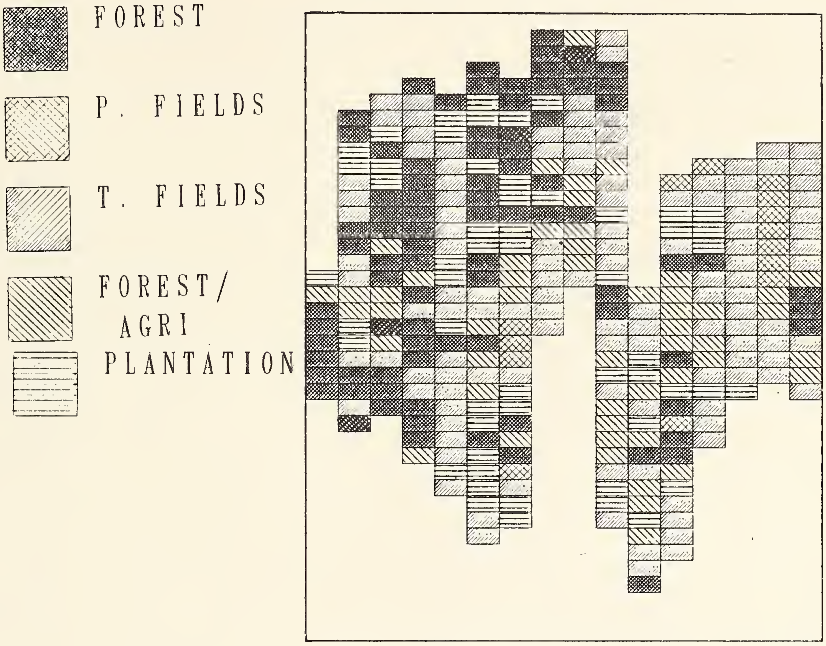
SLOPE


FLAT
GENTLE
UNDULATING
STEEP
PRECIPITOUS

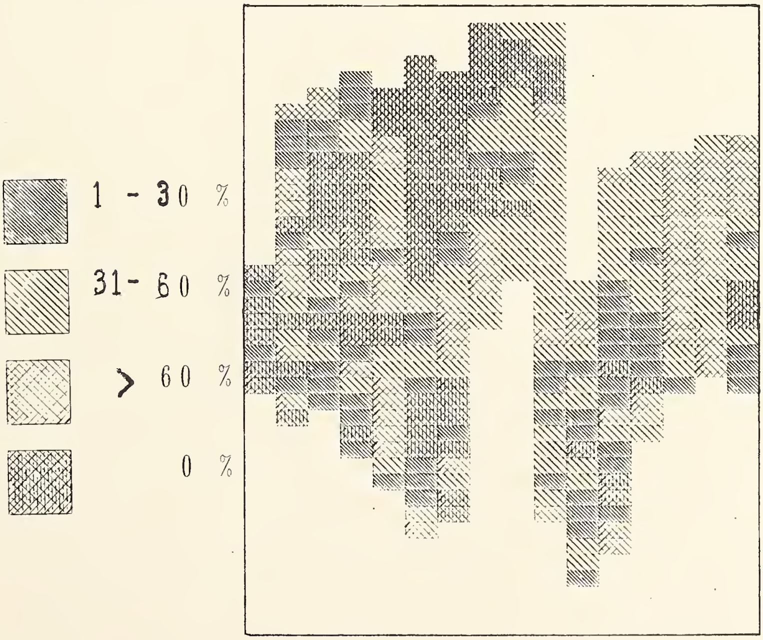
VEGETATION COVER

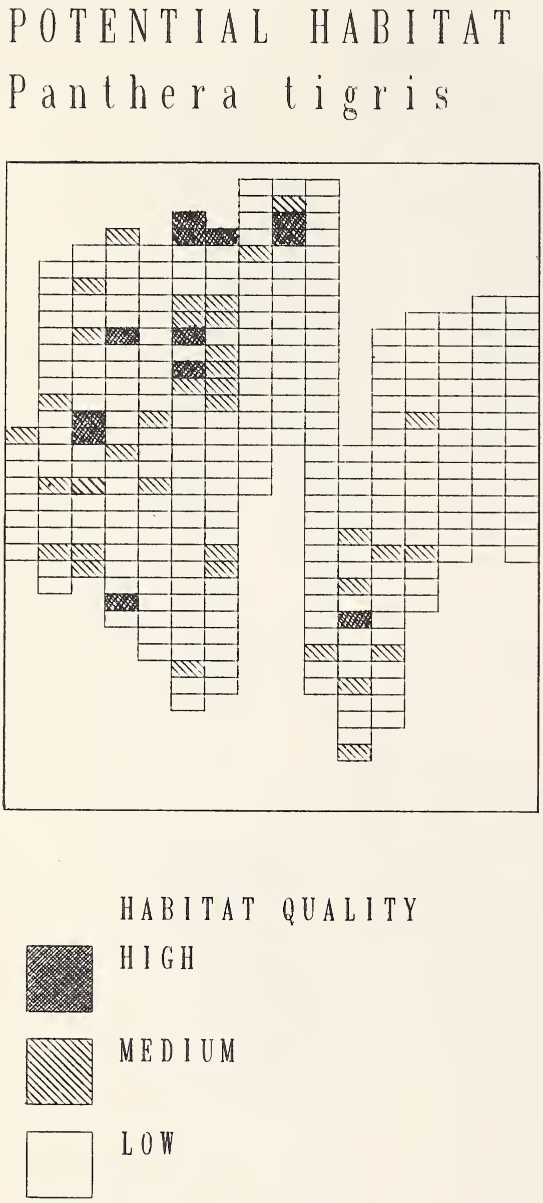

1 - 30 %
31 - 70 %
71 -100 %

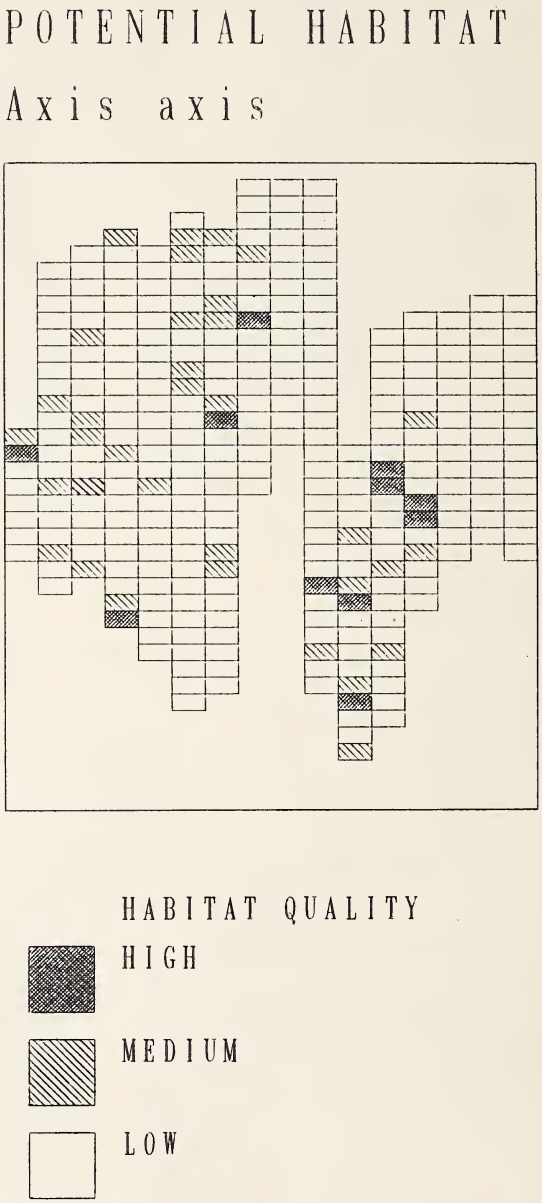
VEGETATION TYPE

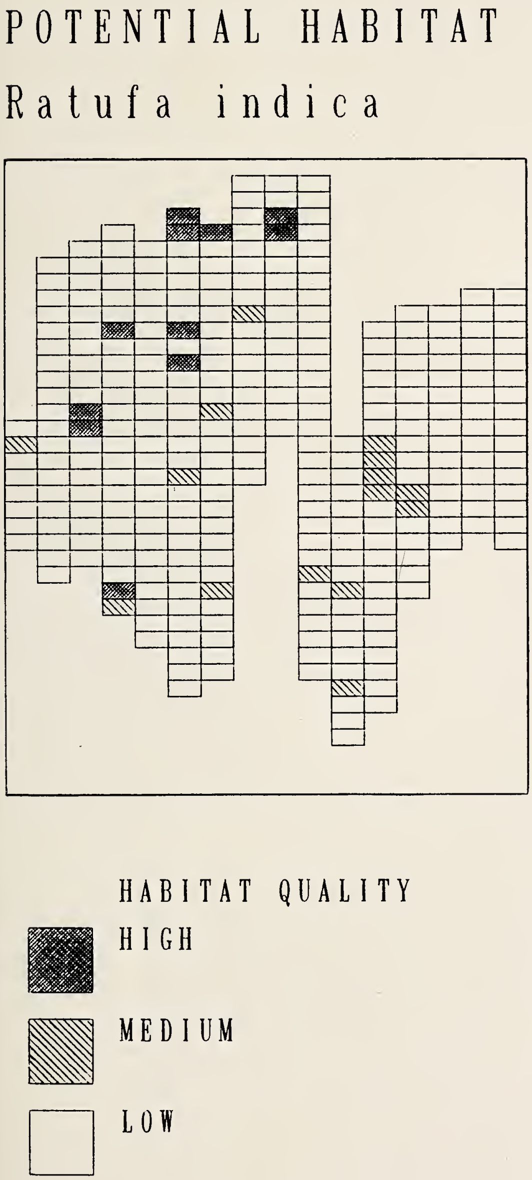

FOREST
P. FIELDS
T. FIELDS
FOREST/ AGRI
PLANTATION

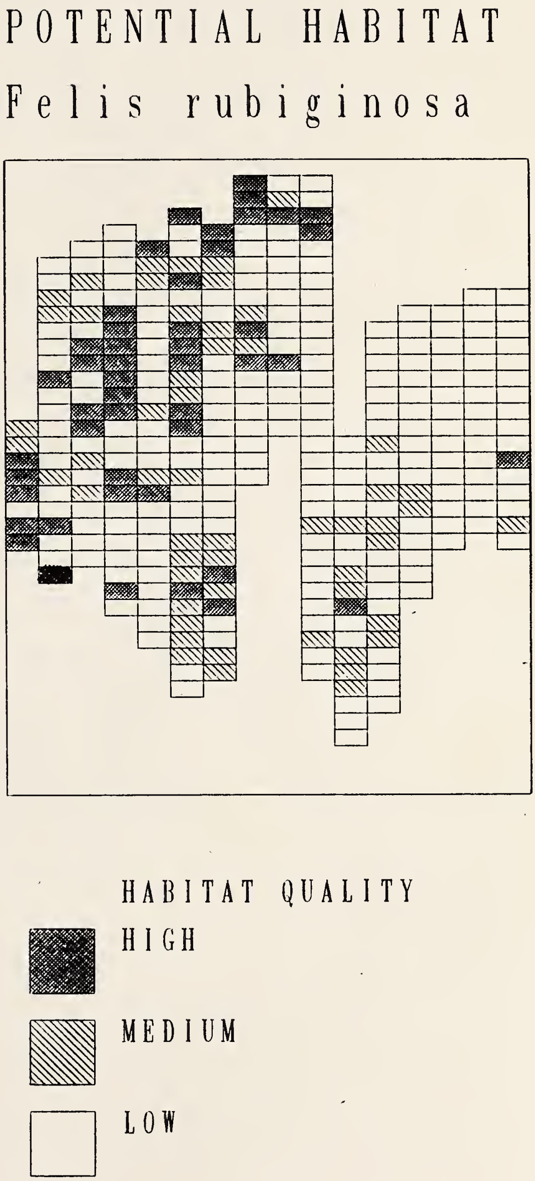
INTENSITY OF AGRICULTURE


1 - 30 %
31- 60 %
> 60 %
0 %


POTENTIAL HABITAT
Panthera tigris
HABITAT QUALITY
HIGH
MEDIUM
LOW


POTENTIAL HABITAT
Axis axis
HABITAT QUALITY
HIGH
MEDIUM
LOW


POTENTIAL HABITAT
Ratufa indica
HABITAT QUALITY
HIGH
MEDIUM
LOW


POTENTIAL HABITAT
Felis rubiginosa
HABITAT QUALITY
HIGH
MEDIUM
LOW

# COMBINED POTENTIAL HABITATS OF KEY SPECIES:

P. tigris
R. indica
F. rubiginosa
A. axis

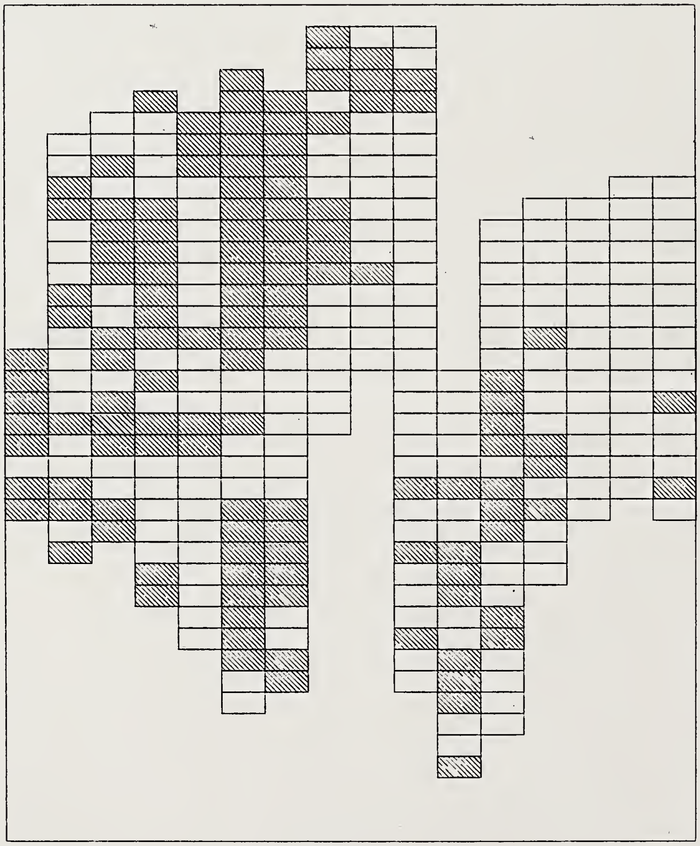


TABLE 1
POTENTIAL HABITAT REQUIREMENTS OF SPECIES BASED ON A COMBINATION OF HABITAT PARAMETERS

| SPECIES | HABITAT PARA / HAB. QUALITY | TOPOGRAPHY | | | | | SLOPE | | | | | COVER | | | VEGETATION | | | | | AGRICULTURE | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | RIDGE | SLOPE | PLAIN | VALLEY | CATENA | FLAT | GENTLE | UNDUL. | STEEP | PRECIP. | 1-30% | 31-70% | >70% | FOREST | P. FIELD | T. FIELD | FOR/AGR. | PLANT. | 0% | 1-30% | 31-60% | >60% |
| Tiger | HIGH | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | | | ● | ● | | | | | ● | | | |
| | MED | ● | ● | ● | ● | ● | ● | ● | ● | | | | ● | ● | ● | | | | ● | ● | ● | | |
| Rusty-spotted Cat | HIGH | ● | ● | | ● | ● | | ● | ● | ● | ● | | ● | ● | | | | | ● | | | | |
| | MED | ● | ● | | ● | ● | | ● | ● | ● | ● | | ● | ● | | ● | | ● | ● | ● | ● | | |
| Giant Squirrel | HIGH | | ● | ● | ● | ● | ● | ● | ● | | | | | ● | ● | | | | | ● | | | |
| | MED | | ● | ● | ● | ● | ● | ● | ● | | | | ● | ● | | | | ● | | | ● | | |
| Spotted Deer | HIGH | | ● | ● | ● | | ● | ● | ● | | | | ● | ● | | | | ● | | | ● | | |
| | MED | | ● | ● | ● | ● | | ● | ● | ● | | ● | ● | ● | ● | | | | ● | ● | ● | | |

All combinations of marked cells correspond to high & medium quality habitat for the respective species; unmarked cells represent unsuitable habitat.

topography and slope remain unchanged; cover can be either 31-70% or > 70%; vegetation could be either a forest or a plantation and agriculture could be 0 or 1-30%. Unsuitable habitat would be areas with steep and precipitous slopes, cover values of 1-30%, P. fields, T. fields or forest/agriculture and areas having 31-60% or > 60% of land under agriculture.

These habitat requirements are depicted as maps in Figures 7-10. Each shaded cell corresponds to a combination of variables marked with an asterisk in Table 1 for high and medium quality habitat for each species. The unshaded cells represent unsuitable habitat.

Fig. 11 is obtained by combining the high and medium quality habitats of all the four species to give the combined potential habitat for these species in the Dangs.

## DISCUSSION

It can be seen from the results that suitable habitat for each of the species individually and for all the four species combined is very patchily distributed. In most of the cases, the best habitat seems to be concentrated in the northern and western part of the Dangs, i.e. around the proposed Purna Wildlife Sanctuary and the Bansda National Park. The only species that seems to have a fair amount of contiguous habitat is the rustyspotted cat. This is supported by the fact that of the four species, this was the one most frequently reported by local people during our surveys. A possible reason for this is that the cat uses steep, rocky, forested areas. From the maps showing slope and vegetation, it can be seen that a large amount of the forest cover is located on the steeper slopes, creating a suitable habitat for this species.

There is hardly any suitable habitat left for the giant squirrel, a likely reason why this species has not been reported for the last 40 years. There are very few spotted deer left in the Dangs today, and this can be attributed to excessive hunting and the fact that most of the suitable habitat for this deer is now under agriculture. The small and patchy distribution of the suitable tiger habitat is obviously not enough to support a population of tigers and these reports need to be confirmed. However, on combining all the suitable habitats, a fairly large and contiguous block of suitable habitat is obtained which, if given adequate protection, might serve to conserve these species in the Dangs. Another possibility which must be explored is to connect different forest patches by means of corridors.

In conclusion, it should be emphasised that this is mainly a theoretical exercise to demonstrate the potential use of GIS and SRF in wildlife conservation and management. These results as pertaining to the Dangs are by no means claimed to be completely accurate as both the recording of the habitat variables as well as the modelling was relatively subjective. Further ground work will be undertaken in order to determine actual habitat preferences of these and other wildlife species. We hope to be able to modify and update the existing maps and upgrade them from the present coarse grid form to a finer scale of maps based on vectors.

However, two facts do emerge: the fragmentation of the habitat and the importance of the Purna forest.

## Acknowledgements

The aerial survey was funded by a grant from the Salim Ali Nature Conservation Fund of the BNHS and the Seth Purshotamdas Thakurdas and Divaliba Charitable Trust. We are grateful to Dr Pratap Saraiya for his encouragement and help in arranging for the latter grant.. The computer analysis was made possible by a grant from Tata Steel. Dr. Werner d'Oleire-Oltmanns and Dr. Walther Berberich from the Berchtesgaden National Park, West Germany, spent a lot of time and effort in demonstrating the possibilities of analysing this data using ARC/ info. Special thanks to Dr Anna Loy, Dr. Fabio Corsi, and Piero Genovesi from the Department of Animal Biology, University of Rome for taking time off from a busy conference to help with data analysis and for getting the maps plotted in record time.

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## Appendix I
## NOTES ON FOUR ENDANGERED SPECIES OF THE DANGS

Rustyspotted cat (*Felis rubiginosa*): A highly endangered cat with a very restricted distribution in the Western Ghats and Sri Lanka. It is a very small, nocturnal cat which favours dense vegetation on broken ground. Atleast four specimens have been collected from the Dangs in the past. It is still known to the local people, but is very difficult to see. The Dangs must offer the best chance for long term survival of this species, based on proper conservation inputs to Purna WLS and other localities.

Giant squirrel (*Ratufa indica dealbatus*): An endemic race of the Indian giant squirrel with distinctive yellow colouring. There have been no collections or confirmed sight records for the past 41 years. It is known by the older local people, but no recent reports were obtained. We have been unable to locate any nests which were earlier concentrated in the Purna region. Loss of habitat, including the felling of large trees for timber is a possible reason for the decline of this species.

Tiger (*Panthera tigris*): Tigers have been reported from the Dangs for several years, but no concrete evidence of their existence in this area has been obtained. A census conducted in April 1989 reported the presence of about six tigers in this area. Presence of tigers in this area in the past is reported by almost all the local people. It is possible that a small population of tigers does still exist in the Dangs, and these reports need to be confirmed.

Spotted deer (*Axis axis*): This common species of deer has been practically exterminated in the Dangs due to hunting and loss of suitable habitat. The only remaining population is now found in the Bansda National Park. With proper management inputs and adequate protection, reintroduction of this species could be attempted in the Dangs.

# GROWTH, MATURATION, AND PHYSICAL CHARACTERISTICS OF NILGIRI TAHR, *HEMITRAGUS HYLOCRIUS* (OGILBY)[1]

CLIFFORD G. RICE[2]

(*With two plates & three text-figures*)

Horn growth and changes in pelage patterns were monitored during a 2-year study of Nilgiri tahr (*Hemitragus hylocrius*) in Eravikulam National Park, Kerala, India. In Nilgiri tahr, mature males have longer horns than do females. It was found that this was primarily because males maintained the high juvenile horn growth rate about 1 year longer than females did.

The pelage of females changed little throughout their lives, but the coats of males gradually changed from the grey coat with black carpal patches of subadults and adult females to deep brown legs, chest and flanks, white carpal patches and silvery back saddle. Mature males also had striking facial markings and larger horns than females of comparable age. On the basis of body and horn size and pelage colour, nine sex and age classes were differentiated

In considering the facets of Nilgiri tahr biology in the context of their environment, it was concluded that in female Nilgiri tahr body configuration and pelage colour are determined primarily by selection incurred by ecological factors. Body size in males has a strong component of sexual selection, and pelage colour in adult males seems to be affected primarily by sexual selection.

## INTRODUCTION

In sexually dimorphic ungulates, it is typical for subadult males to have an appearance very similar to that of adult females (e.g. Geist 1971). As males mature, they gradually acquire distinctive pelage patterns. As such maturational characters are an indication of age, they can be useful in describing the age structure of a population.

Nilgiri tahr males have a distinctive pelage, the most conspicuous feature being a light "saddle" across the back. Males showing this pelage are commonly termed saddlebacks (Davidar 1971, Schaller 1971). Yet, because these maturational characters develop gradually over a period of several years, the potential exists for differing assessments as to what characterizes a "mature" male, or saddleback. Thus Davidar (1972, 1976) and myself (Rice 1984) estimated that saddlebacks made up 4 - 6% of the populations we surveyed, whereas Schaller (1971) reported 9 -11% saddlebacks in the same populations (albeit in different years). Nevertheless, the number of adult (age  2 years) males per adult female in all counts was nearly constant, averaging 0.58 (maximum = 0.62, minimum 0.54), while the number of saddlebacks per adult female showed substantial variation (0.27 and 0.33 for Schaller, 0.10-0.14 for Davidar and myself). It therefore seems likely that Davidar (1972) was correct in attributing these discrepancies to different standards used in classifying males. Nevertheless, neither Davidar nor Schaller gave more than minimal descriptions of the characteristics they employed in classifying male Nilgiri tahr. One objective of this paper is to delineate specific characteristics which can be used in sex and age classifications of Nilgiri tahr.

As with any physical traits, the body size and pelage of an animal are influenced by natural selection. The second objective of this paper is to interpret the physical characteristics of Nilgiri tahr in light of the social and physical environment in which they live.

## STUDY AREA AND METHODS

The findings presented here are based on observations made in Eravikulam National Park, Kerala, India, between August 1979 and September 1981. At Eravikulam, Nilgiri tahr inhabit the fringes of a rolling grassy plateau. Adjacent cliffs are used primarily as escape terrain and for giving birth. Nilgiri tahr occurred in large groups (up to 150 individuals) and during the rut numerous males competed for access to oestrous females.

During the course of the study one subpopula-

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tion of about 120 animals was habituated to my close proximity. To facilitate individual recognition, 51 colour coded collars were placed on adult females. Adult males were recognized on the basis of natural marks (broken and chipped horns, scars). The identities of individual young (less than 1 year old) tahr were determined through interactions with their mothers.

Initially, I followed Schaller's (1971) outline of sex and age classes, but as the study progressed I refined this system, dividing the initial 6 classes into 9 by the end of the study (see below). Nilgiri tahr ≥2 years old could be aged on the basis of body size and horn length. Individuals >2 years old were aged by counting horn rings. Horn lengths of young were visually estimated.

## RESULTS

Male Nilgiri tahr grow to about 110 cm at the shoulder (Prater 1980), and weigh about 100 kg (Wilson 1980), a stature they reach at about 6 years of age. Measurements from photographs indicated adult females were 75% the size of males, or about 80 cm at the shoulder. Females weigh about 50 kg (Wilson 1980).

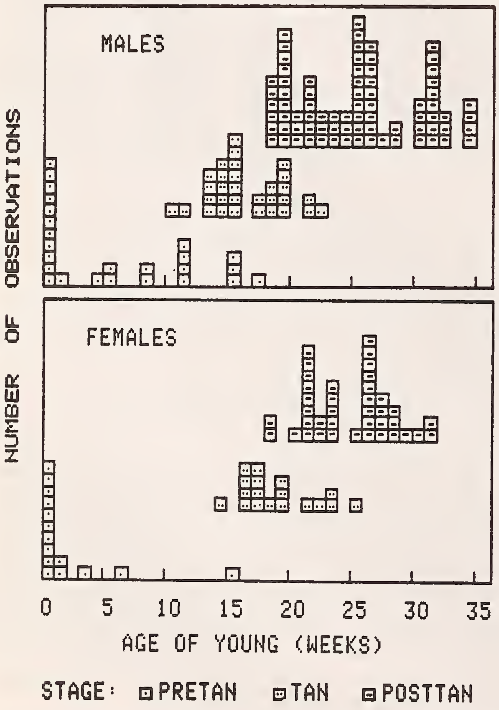


Fig. 1. Observations of Nilgiri tahr young pelage stages.

Nilgiri tahr were born with an overall grey coat (which I termed the pretan stage), with carpal patches and facial markings absent or inconspicuous. At about 10-14 weeks of age they grew a light a tan fluffy coat (tan stage), which was shed at an age of about 20 weeks (post tan stage, Fig. 1). The first records of tan young came 3 weeks later for female young than for males; the mean age of tan female young was 2.6 weeks greater than that for male young (18.6 *v.* 16.0 respectively), and female young were last recorded in tan phase 3 weeks later than male young. Although the first female young were recorded in post tan phase at the same age as the first male young, the first peak in female young post tan observations is 2 weeks after the first peak in male young post tan observations. Overall, there was an evident trend for females to pass through these stage changes about 2 weeks later than males did.

The post tan coat was the same as seen in adult females and young males. The black patch on the anterior of the forelegs, just above the carpal joint, contrasted with the overall grey pelage. The abdomen and centre of the chest were off-white, as were the insides and backs of the legs. A narrow mane of black hairs extended from the top of the nape to the tail. An ill- defined stripe of light coloured hairs dropped from just anterior to the eye toward the mouth. Light brown hairs covered the tip of the muzzle and the area around the eyes.

As females matured there was virtually no change in this pelage pattern. Males, however, continued to change as they grew older. At about four years of age (when they surpassed females in body and horn size), the top of the black carpal patch began to turn white. The proportion of white in the patch increased until it was all white by about 5 years of age. At the same time the fronts of all four legs changed to a dark brown as did the lower flanks, the ridge of the muzzle between the light stripes, and a patch below the eyes. A saddle-shaped area of light hair was also usually present, but was not conspicuous at this time. These changes then intensified, as the fronts of the legs turned black (contrasting markedly with the white carpal patch), the facial pattern became more prominent, and the general body pelage darkened to brown. The mane grew longer along the neck and the light coloured saddle stood out. In the final stage of development, reached at an age of about 8 years, the black coloration extended onto the shoulders, chest, and neck, and the saddle was a silvery colour. Males reached their fullest development in these traits during the rut (monsoon), and regressed an equivalent of about half a year's maturation during the winter.

In both sexes horns were first visible in the field as buds at the age of 3-4 weeks. Horn length was first estimated at 1 cm about 8 weeks after birth. Horns of females grew slower than those of males, but this difference was not great during the first year. A linear regression model fitted to estimated horn length for male young under the age of 30 weeks gave the equation: horn length = age ( in days) x 0.01940 - 0.09859. The comparable equation for females was: horn length = age x 0.01843 - 0.25533. Assuming continued growth at these rates, the horns of males were 7.0 cm long at the age of 1 year, and 14.1 cm long at 2 years of age, while the horns of females were 6.5 cm long at the age of 1 year, and 13.2 cm long at 2 years of age.

Horn rings were present, but the first was usually indistinguishable, as is the case with Himalayan tahr (Caughley 1965). It was sometimes difficult to count the horn rings precisely in older females, as the later rings were not always clearly demarked. Measurements of intervals between horn rings from skulls collected during the study gave an indication of the growth of horns from the second year onwards (Fig. 2), with growth during the first year estimated on the basis of the above equations. The rate of horn growth had decreased by the second year in females, whereas in males the original rate persisted until the second or third year. After the sixth year the growth rate in males was only slightly greater than that for females. In other words, males grew longer horns than females primarily because they maintained the original growth rate about 1 year longer.

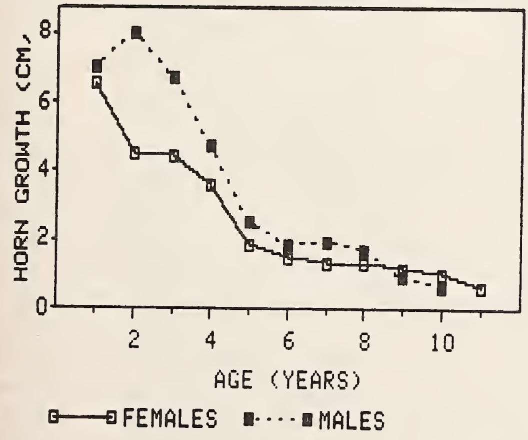


Fig. 2. Annual growth of Nilgiri tahr horns. Growth for the first year was estimated based on visual estimation of horn lengths made during the first 30 weeks of life for 1981 young (see text). Subsequent values are averages from both horns from two individuals in each sex.

The small difference between the predicted and measured lengths for 2 years of horn growth indicated that horn rings were put down at about the same time of year as births occurred, that is January and February. The largest horns I measured were 32 cm long, considerably shorter than the 44 cm maximum listed by Ward (1910).

The horns of males were also wider and deeper than those of females. The horns of adult males measured about 7.2-7.5 cm front to back. Those of adult females measured 4.6-5.0 cm.

Except for the last few centimetres, where the horn is nearly straight, Nilgiri tahr horns show a constant curve (Fig. 3), indicating a constant ratio through time between growth rates for the front and back of the horn. There is an anteriorly projecting rib on the medial anterior corner of the horn. This is first evident during the second year of growth, and is fully developed sometime in the third year. Horns are conical during the first year of growth, after which they develop a flattened inner margin (Rice 1984, Schaller 1971). The horns do not curve outward or flare, and can be laid on a flat surface with the inner margin facing down. Relative to the skull, the horns are rotated away from the longitudinal plane so that the flattened surfaces form an angle of about 20x, and the horn tips are further apart than the bases of the horns.

Based on these maturational changes, the following sex and age classes were recognized. Abbreviations adopted during this study are given in parenthesis.

*Young* (*Yg* ). Age up to 1 year. Horns less than 7 cm. Overall pelage grey.

*Yearling* (*Y l* ). At the start of the birth season,

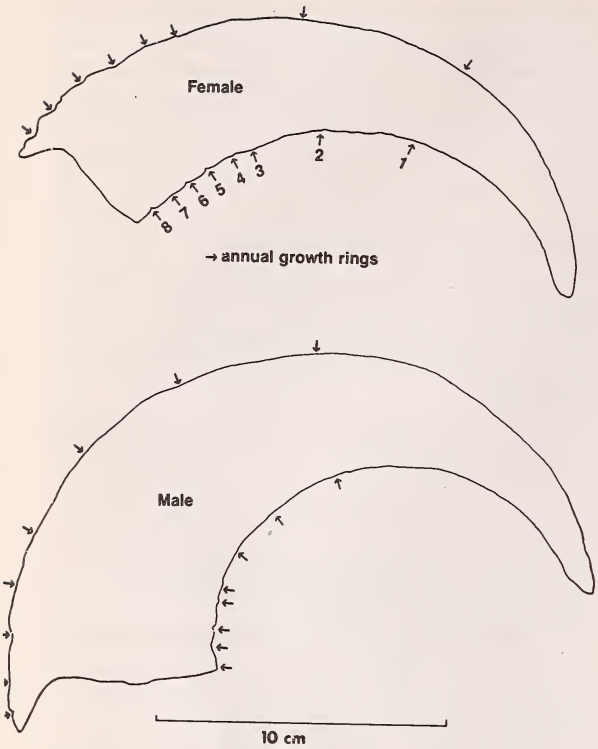


Fig. 3. Outline of Nilgiri tahr horns.

all Yg were advanced to Yl. Age usually 1-2 years. Horn length usually 6-14 cm. Overall pelage grey.

*Adult female* (*F, Plate 1*). Age 2+ years. Standing about 80 cm at the shoulder. Horns upto 30 cm long, and more slender than those of adult males. Overall pelage grey.

*Light brown male (Lbm)*. Age 2-4 years. About the same size as adult females. Distinguished from them by presence of scrotum and penis sheath or (with experience and at close distances) by heavier horns. Overall pelage grey with black carpal patch.

*Large light brown male* (*Llbm, Plate 2* ). Age *c*. 4 years. Slightly larger and stockier than F's. Horns slightly larger and heavier. At least half of carpal patch white. Overall pelage grey.

*Dark brown male* (*Dbm*). Age *c*. 5 years. Horn and body size greater than in females. Carpal patch white against dark brown lower forelegs. Facial markings distinct. Overall pelage brown. Light saddle may be present, but not distinct.

*Saddleback* (*S, Plate 1* ). With three subdivisions:

1 (*S1* ): Age *c*. 6 years. Off-white or tan saddle distinct. Black on legs but shoulders and neck dark brown.

2 (*S1-2* ): Age *c*. 7 years. Saddle may be silvery. Black extending onto shoulders but not to withers.

3 (*S2* ): Age 8+ years. Saddle silvery. Black extending to withers and neck.

Duringthe 1981 rut I aged all the males present in the Vaguvarrai study area (Table 1). The distribution of ages by class showed that the male classes were closely related to age.

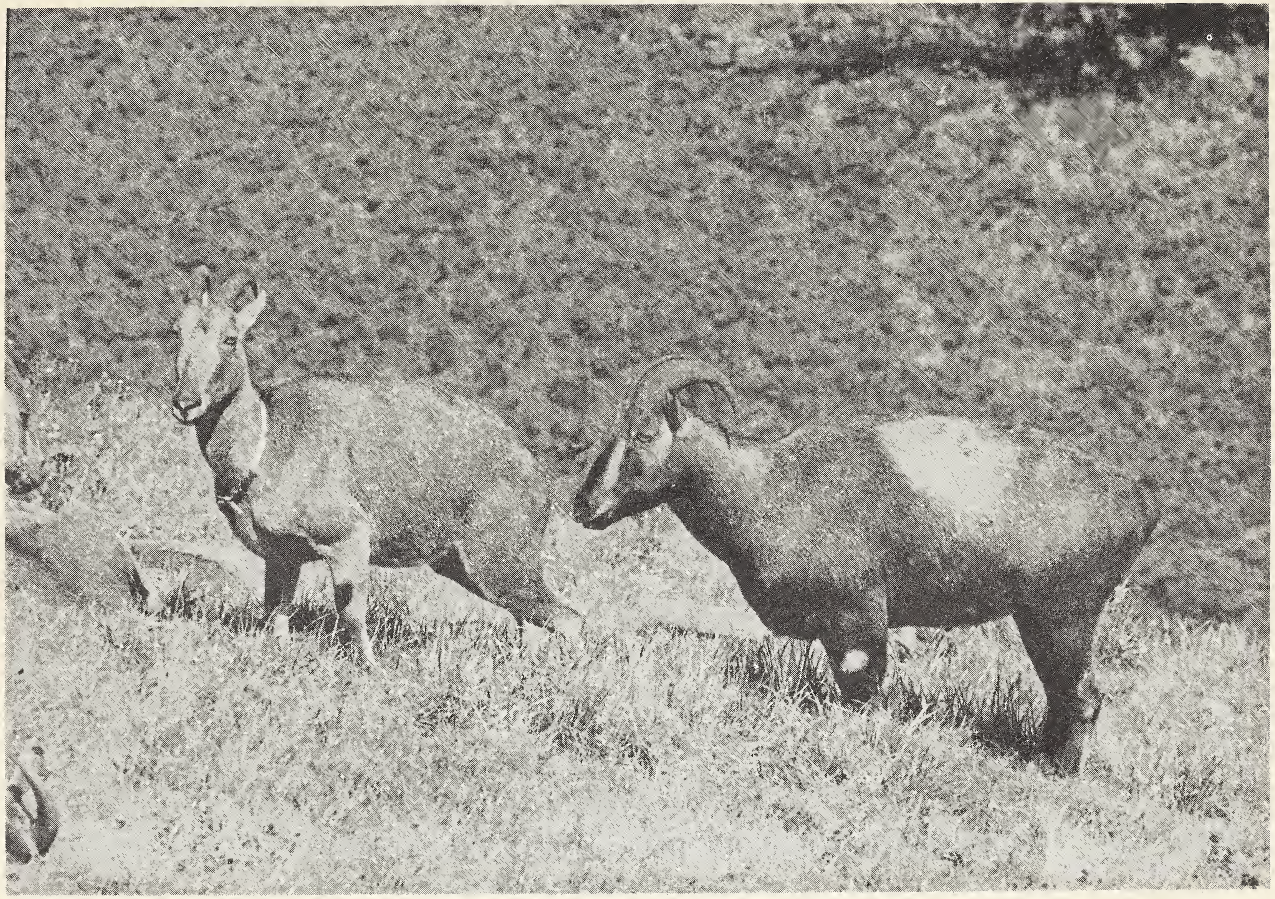
## DISCUSSION AND CONCLUSIONS

Body size and configuration can be viewed as the combined results of selection for ecological factors and sexual selection (Selander 1965). In polygynous species, both types of selection influence the traits of males, while the characteristics of females are mostly the result of selection for ecological factors (Clutton-Brock *et al.* 1982). In Nilgiri tahr (and other Caprinae) sexual dimorphism in body size can be explained a result of differences in these selection pressures, particularly escape ability (selection for ecological factors) and competition between males over access to oestrous females (sexual selection). In caprids, the importance of escape ability as a factor in natural selection is evidenced by the degree to which the availability of escape terrain determines habitat use. For instance, mixed groups of Nilgiri tahr confine their activities to the steep cliffs and the grasslands within 500 m of the cliffs despite the availability of otherwise appropriate habitat at greater distances.

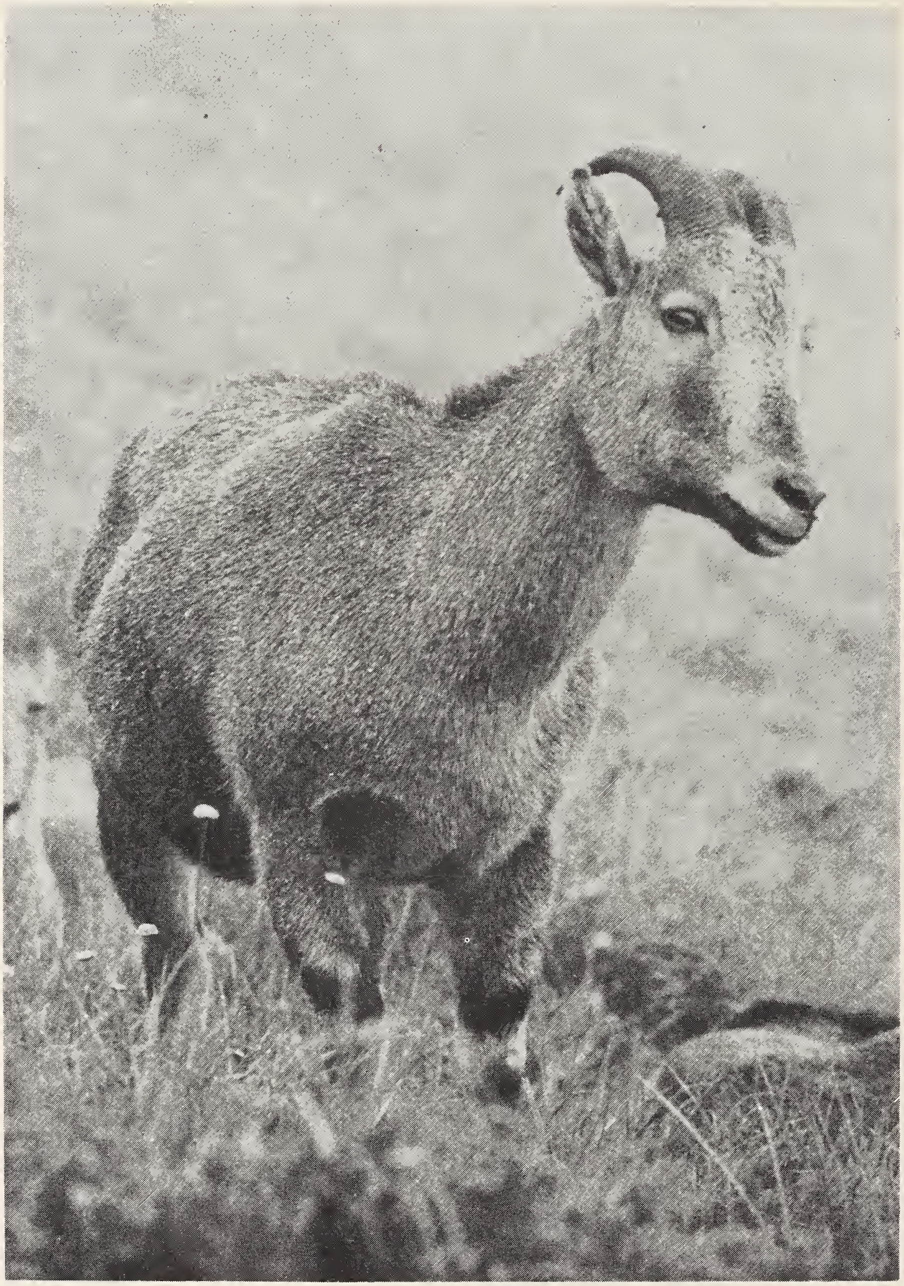
Size is an important factor affecting ability to negotiate precipitous terrain, as was evident when courted Nilgiri tahr females led hesitant males over difficult ground. Males were apparently less physically fit in terms of using steep slopes as escape terrain. This was overcome by increased reproductive fitness through sexual selection for large males, as size affects fighting ability and dominance, both of which determine access to oestrous females, and hence reproduction. Large size may have also increased the ability of males to outrun or confront predators on open ground and this may be one reason why they were seen further towards the

PLATE 1

Rice: *Hemitragus hylocrius*



Adult female (*left*) and saddleback (male) Nilgiri tahr. (*Photo*: Author)



Large light brown male Nilgiri tahr. The carpal patches are in the first stages of changing from black to white. (*Photo*: Author) centre of the plateau than were mixed groups (Rice 1984).

The grey coats of female and subadult Nilgiri tahr blended extremely well with the gneiss cliffs which were escape terrain of the tahr. These animals were surprisingly easy to overlook even on the open grassy slopes, especially in the overcast and rainy conditions common throughout much of the year. Such cryptic coloration is widespread in the Caprinae (Schaller 1977); the most obvious conclusion is that it serves to make detection by predators less likely. Saddlebacks, in contrast, were very conspicuous. Their deep brown coats and silvery saddles stood out at distances of 1 km or more. Whereas male body size may be considered a compromise between the dictates of selection for ecological factors and sexual selection in Nilgiri tahr, selection for ecological factors seems to have been overwhelmed by sexual selection in affecting pelage coloration of mature males.

Male maturational changes are closely related to age and hence size and fighting ability. They may, therefore, be considered as a static (or continuous) dominance display, making them analogous to the horns of bighorn sheep (*O. canadensis*, Geist 1971). This was supported by the response of dominant saddlebacks in mixed groups to the arrival of a new saddleback, which consisted of staring, spraying urine, and object aggression (such reactions were not elicited by other animals). Maturational characters were also accentuated in another dominance display, the hunch (Rice 1984, 1988). The hunch was given in broadside orientation,displaying the dark flanks and contrasting saddle, and the erected mane flipped back and forth with the steps of the displaying male.

TABLE 1
NUMBER OF MALES OF EACH AGE AND CLASS IN THE VAGUVARRAI INTENSIVE STUDY AREA ON 20 JULY 1981 BASED ON HORN RING COUNTS. SEE TEXT FOR CLASS ABBREVIATIONS

| | Class | | | | | |
|---|---|---|---|---|---|---|
| Age (years) | S2 | S1-2 | S1 | Dbm | Llbm | Lbm |
| 2 | – | – | – | – | – | 2 |
| 3 | – | – | – | – | 2 | 3 |
| 4 | - | - | - | 1 | 6 | – |
| 5 | – | – | – | 5 | – | – |
| 6 | – | – | 3 | – | – | – |
| 7 | – | 2 | – | – | – | – |
| 8 | 1 | – | – | – | – | – |

Male Himalayan and Arabian tahr also have maturational characters. These species have long bushy growths of hairs, particularly on the shoulders (Harrison 1968, Schaller 1977). Such a long, thick covering would be a serious impediment when saturated with rain, which may be why male Nilgiri tahr lack such pelage.

Both sexes of Nilgiri tahr have distinct carpal patches, those of each sex contrasting sharply with the colour of the surrounding pelage. These patches remain nearly constant throughout life (except in males during the switch from black to white), so they are not solely of maturational significance. Their distinctiveness would seem to indicate some function, but they are not employed in any particular displays and their importance remains unknown. Conspicuous markings are present on the forelegs of several *Capra* species and bharal (*Psuedois nayaur*, Schaller 1977), where it is prominently displayed as these animals rear to clash - something Nilgiri tahr rarely, if ever, do (Rice 1984, 1988).

The function of the tan coat Yg Nilgiri tahr grow and shed at 3-6 months of age is also unclear. The length and fluffiness of the coat suggest increased insulation, but the advantages of such a coat would be greatest during the first couple of months of life when body size is smaller, minimum temperatures are lower. It is probably significant that most Yg shed their tan coats just before the monsoon, thus avoiding the costs of thermal and energy losses which would probably be incurred by carrying a water-logged shaggy coat. The tan coat may be a social signal which serves to reduce aggression by adults (Hrdy 1976), but there was no obvious indication of this in Nilgiri tahr. The tan coat of Nilgiri tahr young differs significantly from the juvenile coats of most mammals. Young mammals are typically born with their juvenile coloration and lose it as they mature. The coats of neonate Nilgiri tahr are much like those of adult females and they subsequently acquire the tan coat.

Annual horn growth in Nilgiri tahr is nearly asymptotic at about 1 cm/year for both males and females (Fig. 2). This differs from Dall sheep (Bunnel 1978) where horn growth in males is greater than that of ewes at all ages.

It is hoped that the sex and age classifications outlined here will serve as a reference for further investigations on this species.

## ACKNOWLEDGEMENTS

The American Institute of Indian Studies, the Caesar Kleberg Program in Wildlife Ecology, and Wildlife Conservation International of the New York Zoological Society provided funds for this study. The U.S. Fish and Wildlife Service assisted with essential logistical support. I gratefully acknowledge the permission to work in Eravikulam National Park granted by the Government of India and the Kerala State Government. Invaluable assistance with daily logistical needs was provided by members of the High Range Wildlife Preservation Association.

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# RECENT ORNITHOLOGICAL RECORDS FROM PAKISTAN[1]

T.J. ROBERTS[2]

(*With a text-figure*)

This note is complementary to previous contributions to the *Journal* on the available information about the distribution and status of certain bird species from this region. Vide: Roberts 1984, *JBNHS* Vol. 81 and Roberts *et. al.* 1985, *JBNHS*, Vol. 82.

**Slavonian Grebe** *Podiceps auritus*

In mid-January 1984, I carried out waterfowl surveys around the two principal lakes in central Baluchistan, which province covers the southwestern region of Pakistan. Due to good rains Zangi Nawar Lake (29° 27' N, 65° 47'E) comprised an extensive series of lagoons which could only be surveyed effectively from a boat, which in this instance was an ill- designed bath-tub sized affair. While returning on January 17th evening from an extended afternoon in this craft, during which more than 200 Blacknecked Grebes (*Podiceps nigricollis*) had been counted, a single bird, swimming by itself, at once attracted attention by its seemingly more contrasting black and white plumage and more upright neck carriage. It appeared to all intents to be a Slavonian Grebe. Due to the precarious nature of the boat, neither prolonged nor careful observation was possible, and this, coupled with general fatigue, I am ashamed to confess, made me decide to forget the incident, knowing that the species had never before been recorded from the subcontinent. However, on January 20th a visit was made to the much smaller Kushdil Khan lake in Pishin district, where it was possible to conduct waterfowl counts from the shore, using a tripod mounted telescope. Imagine my delight, therefore, when in a secluded arm of the lake I found a pair of Slavonian Grebes, which I was able to sketch and to watch for over an hour.

My home, on the island of Anglesey (North Wales), offers shelter each winter, around the coast, to a number of Slavonian Grebes and Rednecked Grebes (*Podiceps grisegena*). I was therefore well aware of the extreme similarity in appearance between *P. auritus* and *P. nigricollis* from past experience. Indeed, juvenile birds might well be indistinguishable in their first winter unless observed at very close range. Some commentary on their distinguishing field marks may therefore be of interest to the reader.

*P. auritus* has the same rather dumpy appearance and fluffy rear end as the Blacknecked Grebe. It is smaller, shorter necked and looks more black-and-white than the Rednecked Grebe in winter plumage. It is only slightly larger than *P. nigricollis* but tends to appear more straight necked and larger in the head with a heavier bill. This bill is straight or slightly recurved along the culmen, black in colour, with a pale, horny tip. The tip is very small in area and difficult to see in the field. In *nigricollis* the bill is more slender than that of *auritus* and is slightly uptilted along the culmen without any paler tip. The white wing bar in *auritus* is considerably wider than in *nigricollis*; but this is generally not helpful unless the bird flies, as it is invisible in most swimming birds.

Perhaps the best distinguishing characters relate to the pattern of black on the crown and white on the cheeks and foreneck. In *auritus* the white area on the cheeks is much more extensive, especially extending towards the hindneck or auricular region and extending up around the base of the eye. In *nigricollis* the black of the crown tends to extend to just below and around the eye and onto the auricular region. It is significant that the dark colour of the crown and hind neck in the Asiatic population of *P. auritus* is less silvery grey and more black than in the North American population, in winter plumage. I have, however, seen juvenile wintering specimens of *auritus* in Anglesey with equally extensive amounts of grey-black on the hind crown as in *nigricollis*. The view of *auritus* from the back of its head and neck does, however, present a very characteristic pattern when compared with *nigricollis*, and to my mind, is the best distinguishing field character. (Fig.1).

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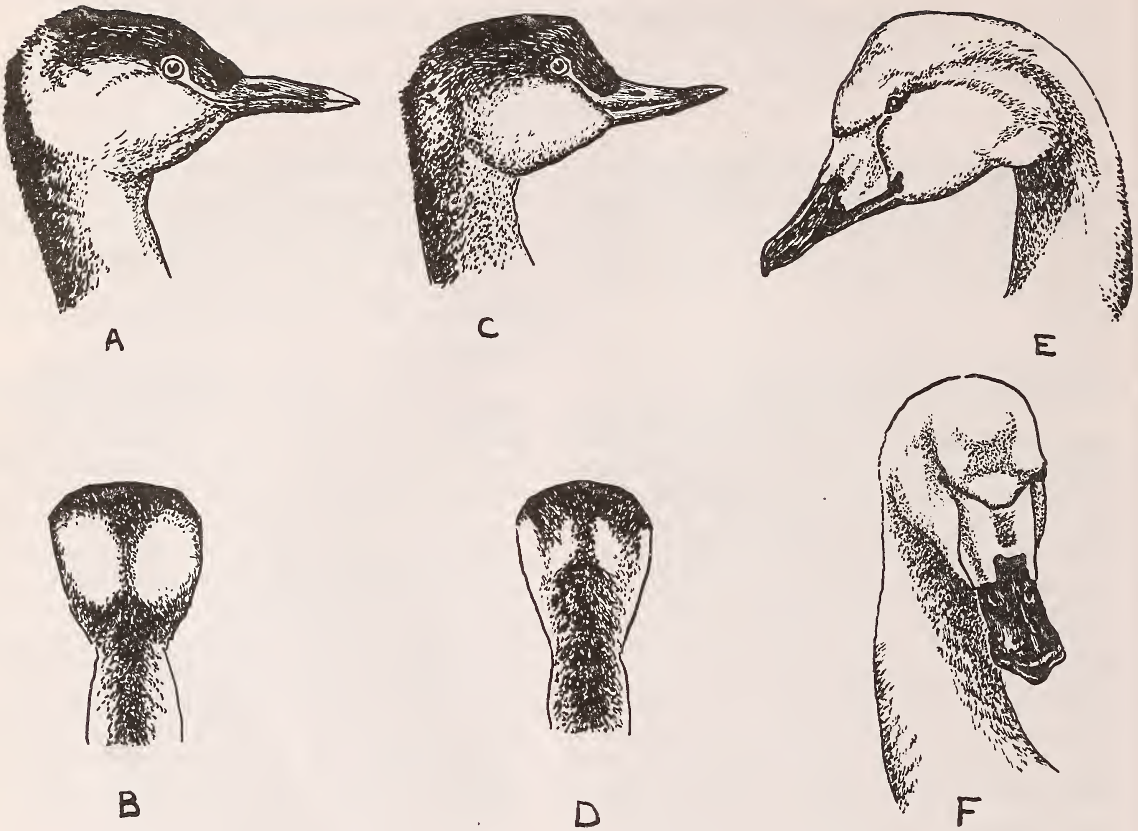

Fig. 1. A-F: A: *Podiceps auritus* —winter plumage; B. Same, view from rear of head; C.*Podiceps nigricollis* — winter plumage; D. Same, view from rear of head; E. Captive Bewick's swan, copied from photograph presumed to be Jankowski's Swan *Cygnus columbianus jankowskii*; F. Same, front view.

Due to other writing commitments, I failed to submit any account of this (presumed) first record for the species. In January 1987, Mr. Mark Mallalieu and Mr. Ashiq Ahmad, while conducting waterfowl counts in the Punjab Salt Range lakes, encountered a pair of Slavonian Grebes on Khabbaki lake (M. Mallalieu, *pers. comm.*, February 1987) and this new record has been submitted for publication.

Coincidentally, a single Slavonian Grebe was captured on film in January 1986 by Mr. Naseer Tareen, the distinguished wildlife photographer. This bird was filmed on Kand lake, a very small body of water close to the sea coast in Las Bela district of Baluchistan, near the village known as Habb Chowki. Mr. Tareen was unaware of the species he was photographing until he showed his film to me in February 1987. It was a close-up view and followed earlier shots of a party of 7 or 8 Blacknecked Grebes. This film clip was then shown to R. Passburg,an ornithologist with considerable experience of *P. auritus* from its wintering grounds on the Caspian sea, and he confirmed my identification. This, therefore, constitutes the third reliable record for this species within the past several years.

Normally the species spends the winter along coastal areas and in the sea and for this reason has probably not been recorded hitherto from the Indian subcontinent. Now that some of its haunts have been located, it may well turn out to be a regular, though uncommon, winter visitor.

**Alpheraky's Swan or Jankowski's Swan**
*Cygnus columbianus jankowskii*

There is still some disagreement amongst taxonomists and experts about the classification of this eastern Siberian breeding population of Bewick's Swan. The Editors of Volume I, BIRDS OF THE WESTERN PALEARCTIC (S. Cramp *et al* 1977) do not consider *jankowskii* to be a valid subspecies (p. 385), but it is listed separately as Jankowski's Swan in Ali and Ripley's HANDBOOK (Vol. I, 1968, p. 135).

The winter of 1984-85 was a swan year for the region, with several local newspaper reports of swans (not identified as to species) being sighted in Baluchistan and Sind. Two were seen in January of that year on a temporary lake near Turbat, in southern Baluchistan, by Ashiq Ahmad, one of them (regrettably) killed by a local hunter (A. Ahmad, *pers. comm.* to author, 1986). A single swan was observed and photographed by a number of keen bird, watchers in January 1985, on Haleji Lake, a wildlife sanctuary 72 km northeast of Karachi. It later flew to the adjacent Hadiero lake, approximately 16 km further east. Its relatively small size and short neck suggested that it was a Bewick's Swan rather than a Whooper Swan (Rolf Passburg *in litt.* to author, January 1985).

When I visited Pakistan in May 1985, I discovered this same bird being exhibited in Karachi zoo, having been trapped and sold to the zoo by local professional fishermen who live on the shores of Hadiero Lake. I took photographs of this captive bird and sketches are presented herewith. Regrettably it succumbed during the hot weather of 1985. Alpheraky's Swan is not distinguishable from other populations of the Bewick's Swan by differences in body size, but rather by the more extensive area of yellow on the upper mandible (J. Delacour, WATERFOWL OF THE WORLD, Vol. I and Déméntiev and Gladkov, BIRDS OF THE SOVIET UNION, Vol. 4, 1952). Based upon these published descriptions and Peter Scott's painting in Delacour's book, the swan which visited lower Sind was from this eastern Siberian breeding population, and could be described as Jankowski's, Bewicks, or Whistling Swan.

**Indian Cuckoo** *Cuculus micropterus*

In Ali and Ripley's HANDBOOK (Vol. 3, 1969, p. 205) the distribution of this cuckoo implies that it does not occur in the Himalayan foothill region of Pakistan, but that it does occur in the less arid plains portions of the country and in the foothills from Kashmir eastwards. The author, during 34 years of continuous residence in Pakistan, mostly in the Punjab, never came across it, nor did Hugh Whistler include it in his published account of the birds of Rawalpindi district and the Murree hills (Whistler, *Ibis*, 1930, p. 252). In the late summer of 1984, however, one did turn up around Islamabad and haunted the wooded shores around Rawal Lake during late June upto early August, where David Corfield saw it and tape-recorded its calls. Playback of its calls heard in August 1984, compared with my own recordings made from Malaysia, revealed no dialectical differences, the four- noted song being identical in time sequence and pitch in both the Rawal Lake and Malaysian birds. It would appear to be a rare straggler this far west in the outer foothill or Shiwaliks zone of the Himalayas.

**Spotted Piculet** *Picumnus innominatus*

In Ali and Ripley's HANDBOOK, the distribution of this piculet is given as extending from about Abbottabad in Hazara district and eastwards (Vol. 4, 1970, p. 172). In fact, around Abbottabad, there is no suitable habitat as it is a relatively open, wide, treeless valley with rice and tobacco cultivation in the summer, and wheat crops predominant in winter. It is known, however, as an occasional wanderer into the outer foothill zone around the Murree hill range with two definite sightings in recent years in the Margalla hills (covered by dry tropical deciduous scrub forest). This region has been well surveyed by birdwatchers since the establishment of Islamabad as the capital city. A single bird was seen in July 1977 by Kamal Islam (*pers. comm.*, 1977) and in April 1982 (again a single bird, probably a female) by D. Corfield (*pers. comm.*, 1982). The author never encountered it in the Margalla hills during over 15 years of intermittent observations at all months of the year and spanning many hundreds of hours, nor did H. Whistler include it in his account of the birds of the region (Whistler, *Ibis*, 1930).

In April 1984 , Richard Grimmett and Craig Robson, whilst conducting pheasant surveys in the Kaghan valley (Hazara district), saw several piculets in Malkandi forest (34° 41'N, 73° 35'E), which is located at the bottom of the valley at about 1200 m elevation and 64 km northwest of Abbottabad town. This patch of forest is atypical for the region in having a preponderance of deciduous tree species and a luxuriant undergrowth with bushes of Sumac (*Rhus cotinus*), many Sycamore (*Acer pentapomicum*) and Mountain Ash (*Fraxinus xanthoxyloides*) trees. Realising that this was a most exciting discovery I made a visit to the same locality in June 1984, and after staying two days in the forest hut, was able to locate 3 or 4 pairs, which were again seen in May 1985. Judging from calling males, there might be a small colony at Malkandi comprising of as many as 7 or 8 pairs and they undoubtedly occur here as an isolated and disjunct population, as also is the case in northeastern Afghanistan, where a small population was discovered by Dr. Kulmann in 1963 near Pechtal, Nuristan. These were again located in the same locality in Nuristan in 1965 by Jochem Niethammer (Niethammer, *J. Journ. Fur Ornith:*, 1967).

**Grey Hypocolius** *Hypocolius ampelinus*

This strange and little-known bird is a desert adapted frugivore, endemic to the harshest regions of the Middle East. It is believed to be quite nomadic in its habits, according to local rainfall pattern and food availability and there are hardly 3 or 4 records for the whole subcontinent since it was first discovered on 6 March 1875 by W.T. Blanford from a wintering bird found in the Kirthar hill range on the Sind/Baluchistan border (Blanford, *Stray Feathers*, 1875, p.352).

In the winter of 1983-84 there must have been an irruption of this species westwards across Baluchistan, as it was regularly encountered on the Sind/Baluchistan border in the Habb river valley by the author during several visits to the area, from early February up to mid-March. In a day's search, 5 or 6 could always be located and on one occasion with R. Passburg a flock of 17 birds were watched feeding at close range. Their principal food was the ripe berries of *Zizyphus mauritiana*, but the last mentioned flock settled in a grove of *Prosopis spicigera* trees where they were actually nipping off and eating the leaf buds of this thorny Acacia.

In the winter of 1984-85, diligent search in the same area failed to reveal any. During a visit to Zangi Nawar lake in the Chaghai desert of western Baluchistan in early May 1985, the author was thrilled to encounter, at sunset, a flock numbering between 30 and 40 of these birds, which came into roost together in a patch of tamarisks and tall Phragmites reeds. This area, some 644 km northwest of the Habb valley, comprises an extensive sand-dune desert tract, seeming to lack any suitable fruit bearing bushes or trees such as would attract these birds. They might have chosen the area for roosting because of the proximity of water and thick cover. They are very strong flyers, preferring a fairly high trajectory when moving from one feeding spot to another, which does suggest that they are well able to forage over a wide area, and that like all birds adapted to exploit an abundant food source (such as berries), once located, they probably find that gregarious roosts outside the breeding season are advantageous. Unlike the relatively silent birds encountered in the Habb valley, these birds in May were very noisy, the males singing persistently and excitedly and individuals already consorting in pairs as they went to roost. This suggested that they were getting ready to breed soon.

**Blackbrowed** or **Golden Spectacled Flycatcher Warbler** *Seicercus burkii*

Though Ali and Ripley's HANDBOOK (Vol. 8, 1973, p. 182) gives the distribution of this species as including Murree, I had never come across it in Pakistan. Having consulted H. Whistler's comprehensive manuscript notes, lodged in the Bombay Natural History Society's library, I knew that he had come across no records or specimens from the Murree hills and considered that the western boundary of its range was around Dharamsala in Himachal Pradesh. Bates and Lowther did not come across it in Kashmir (BREEDING BIRDS OF KASHMIR, 1952) and the only known record is the reported sighting by Dickinson of a bird near Sonmarg, Kashmir (J. Bombay nat. Hist. Soc., Vol. 63, 1966, p. 204).

In late December 1982, D. Corfield came across a single bird in a stream bed ravine just on the borders of Islamabad city and at the foot of the Margalla hills. It remained in this locality until the end of March 1983 and was shown to the author. It was seen alongside *Seicercus xanthoschistos* which is common in the area, and it was interesting to note that, whilst *xanthoschistos* foraged often in the upper canopy of fairly tall trees, *burkii* had a preference for the shadier forest understorey and especially shrubs and tall weeds along the stream bank. It was quite tame, allowing close observation, and its continued occupancy over nearly 3 months of this small area indicated that they maintain relatively confined winter territories. In late March 1985, two years later, I saw another individual in one of the side ravines of the Margalla hills some 1.5 km north of the previous bird.

Richard Grimmett and Craig Robson saw this species during pheasant surveys in the Kaghan valley. This was in late April 1984, just below the summit ridge of Kadir Gali at an elevation of slightly under 3000 m. It is presumed that at such a high elevation and late date, they would be approaching, or near to, their intended nesting territory. I made two subsequent camping trips to this spot (Kadir Gali) but failed to locate any *Seicercus burkii*. It is certainly very rare in Pakistan but probably a small breeding population exists in Hazara district and winters in the foothills around Rawalpindi. During a visit to Pokhara in western Nepal, the author found this species quite abundant in late March at lower elevations.

**Brown Flycatcher** *Muscicapa latirostris*

This is a very widely distributed flycatcher in southeast Asia, extending as a winter visitor down to Sri Lanka, and eastwards to Taiwan, Thailand, southern Burma and Malaysia (Ben King *et al.*, FIELD GUIDE TO THE BIRDS OF SOUTHEAST ASIA, 1975). On the Indian subcontinent it occurs mostly down the eastern parts, rarely extending into the dryer northwestern region. In the HANDBOOK (Ali & Ripley, Vol. 7, 1972, p. 146) its breeding range is given as spreading across the Himalayan foothills from Chamba in the west (Himachal Pradesh) to Kulu. It occurs in the autumn on passage in the eastern Punjab parts of India, e.g. in Ludhiana and Hoshiarpur (specimens in the Waite collection, British Museum).

I first encountered it in the summer of 1983 on the summit ridge of the extreme southern spur of the Murree hill range, above Lehtrar. Here a single bird was seen in a mature stand of sub-tropical 'Chir' pine (*Pinus roxburghii*) at 1370 m elevation in mid-May. Later a pair were found nesting near Samli forest rest house on 3rd June, about 9 km from the previous location. A pair were again watched on 23 May 1986 in the same locality (Samli Forest Rest House) with Mark Mallalieu, who was able to take very clear photographs.

This species is almost identical in size and appearance to the Sooty Flycatcher (*Muscicapa sibirica*) with which it is quite sympatric in tropical pine forest during the early summer, so that it was only after repeated sightings that I was able to convince myself that it was not *sibirica*. The best field characters which distinguish *latirostris* are the clear, bright yellow lower mandible which is dark and horny in *sibirica*, coupled with the absence of distinctive dark greyish streaking along the flanks and in the pectoral region, which can always be seen in specimens of *sibirica*. Both species tend to show a comparatively large dark eye with a paler whitish eye ring.

The habits of *M. sibirica* in Pakistan are intriguing. It is typically a forest nesting flycatcher but chooses the upper limit of the tree-line by preference, normally being encountered between 2400 m right up to the sub-alpine birch forest zone at 3500 m, where I have watched it nest building as late as mid- June. But in early summer it can be encountered in the sub- tropical Chir pine zone up to late May even though I have no evidence as yet that it breeds at these lower altitudes. On the same day (23rd May) that Mallalieu and I saw and photographed the pair of Brown Flycatchers at 1200 m, we had watched a single Sooty Flycatcher lower down the slope at 900 m. Their very gradual migration in summer to higher breeding areas may therefore somewhat parallel the habits of *Carduelis spinoides*, the Himalayan Greenfinch, which nests both at low and high altitudes over an extended breeding season.

**Jungle Crow** *Corvus macrorhynchos* and
**Carrion Crow** *Corvus corone orientalis*

In May 1984 I managed to visit the Shingar range in the extreme northern boundary of Baluchistan province, in Zhob district. This fascinating range of hills is clothed with a forest of the Edible Seed Pine or Chilghoza (*Pinus gerardiana*), and rises to 2600 m in height. It was here that A.F.P. Christison encountered crows and found a nesting pair on the summit ridge. He took these to be Carrion Crows, even shooting a specimen (not preserved) for identification (Christison, *J. Bombay nat. Hist. Soc.*, Vol. 43, 1942, p. 478). This distribution range for *C. corone* is also given in Ali and Ripley's HANDBOOK (Vol. 5, 1972, p. 259). The Crows are still there, but to the author's surprise and even disappointment, they were all Jungle Crows, at once distinguishable by their longer wedge shaped tails, more heavy bills with distinctively recurved culmen and especially by their repertoire of calls exactly similar to familiar Himalayan birds.

Puzzled by this, I was later able to get in touch with Sir Philip Christison (as he now is) who was kind enough to invite me to his home in Scotland in November 1985. After discussing the problem he expressed the opinion that he was probably mistaken in his identification and that they had in fact been Jungle Crows. This southern extension of their range is not so surprising as the Jungle Crow breeds commonly above 2400 m on the Safed Koh range further north (Whitehead, *J. Bombay nat. Hist. Soc.*, Vol. 20, p. 177 and author obs.). The only places where Carrion Crows breed in Pakistan are at the upper end of the Kurram valley in the villages around Parachinar at about 1770 m elevation. This is at the bottom of the valley below the coniferous forest level. Similarly, it nests in Baltistan (to the west of Ladakh) around some of the villages in the larger, wider valleys such as Shigar and Shyok (Mathews, *JBNHS*, Vol. 42, p. 658)

In winter at Parachinar and in Baltistan in the Indus valley, Carrion Crows and Jungle Crows are sympatric, the latter frequenting valley bottoms and the outskirts of villages, but in summer *macrorhynchos* ascends to the forested slopes to nest and the nest found on the Shingar by General Sir Philip Christison was 9 m up in a Chilghoza Pine at 2600 m elevation.

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# STATUS OF THE SALTWATER CROCODILE (*CROCODYLUS POROSUS* SCHNEIDER) IN THE BHITARKANIKA WILDLIFE SANCTUARY, ORISSA, INDIA[1]

S.K. KAR[2] AND H.R. BUSTARD[3]

(*With four text-figures*)

The status of the saltwater crocodile in the Bhitarkanika Sanctuary of Orissa was determined by combined day and night counts. The adult population (29 individuals) was extremely low, and subadults numbered only six, indicating very poor recruitment in recent years. However, the number of juveniles (61) was good, indicating the likelihood of better recruitment in the years ahead. This enhanced survival of juveniles is a result of management activities, particularly banning the use of nylon gill nets throughout the Sanctuary. A preliminary attempt was made to correlate crocodile numbers with features of the habitat. The mean density for all non-hatchling size classes was 0.87 individual/km.

## INTRODUCTION

The saltwater crocodile in India suffered a dramatic decline in numbers as a result of a combination of poaching and habitat loss (Bustard 1974). The mangrove ecosystem, to which this species is tied in India, is one of the country's most threatened ecosystems. Once cleared and bunded, the fertile alluvium built up by the mangroves provides rich agricultural land. There was a long tradition of bunding and farming on the landward side, combined with rigid protection of the mangrove forests themselves under the Raja of Kanika in Orissa. The mangroves slowly reclaimed land from the shallow waters of the Bay of Bengal and protected the coastline from cyclonic damage. The problem now is that population pressure on good agricultural land combined with the need for fuel wood has resulted in increasing destruction of the mangrove forests.

The rarity of the saltwater crocodile in India was apparent by the late 1960s (Daniel 1970). Bustard and Choudhury (1981) pointed out that the saltwater crocodile is now extinct in the South Indian states of Kerala, Tamil Nadu and Andhra Pradesh, restricted to the Bhitarkanika Wildlife Sanctuary in Orissa, and very rare in the Sundarbans in West Bengal.

Bhitarkanika has been renowned for its saltwater crocodiles. Daniel and Hussain (1975), based on field work during 1973, recorded the continued existence of the Bhitarkanika population of the saltwater crocodile and pointed out the need to stop all felling of mangroves if the habitat for the crocodiles was not totally to disappear.

Bustard (1974) strongly recommended that this area be declared a Sanctuary, and then managed in the interests of the crocodile. Bustard also highlighted the need to protect the mangroves, recommending a total ban on their felling. A similar recommendation was also made by de Waard (1975). At this time the State Forest Department was opening coupes for working by the local people on a 5 year rotation cycle. Such a short rotation cycle (the normal one is 20 years) was contributing to the destruction of the mangrove forests. Furthermore, Bustard pointed out the necessity of stopping all fishing within the area, especially a serious threat to recruitment in the crocodile population, an observation since confirmed (Kar 1981).

The State Government of Orissa accepted these proposals. The area was gazetted a Sanctuary on 22 April 1975; in the following month, fishing was banned throughout the Sanctuary. In 1975, the State Government of Orissa set up a Saltwater Crocodile Research and Conservation Centre at Dangmal in the heart of the Sanctuary with the purpose of quickly multiplying the population using the 'grow and release' techniques for archaic reptiles as recommended by Bustard (1974). An early account of this work is given in Bustard (1975). In 1976, following consideration of the above reports, and advice from the Government of India, the State Government of Orissa completely stopped all fell-

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ing of mangroves.

The saltwater crocodile population was known to have suffered heavy exploitation in the past but no data were available as to its present status. The present paper describes the results of a detailed census carried out throughout the Sanctuary in the period 1 December 1976 to 30 January 1977.

Surveys for saltwater crocodiles were reported on by Bustard (1967, 1970) for Papua New Guinea and Western Australia respectively. Survey methods for *C. porosus* in Australia have been discussed by Messel (1977) and Messel *et al.* (1978) as the basis for extensive surveys of the saltwater crocodile resource of Northern Australian river systems. These methods were then used as a basis of at least 14 monographs now in print, in press, or in preparation, under a general title "Surveys of Tidal River Systems in the Northern Territory of Australia and their Crocodile Populations", plus two monographs referring to selected rivers in Western Australia (Messel *et al.* 1977, Burbidge and Messel 1979).

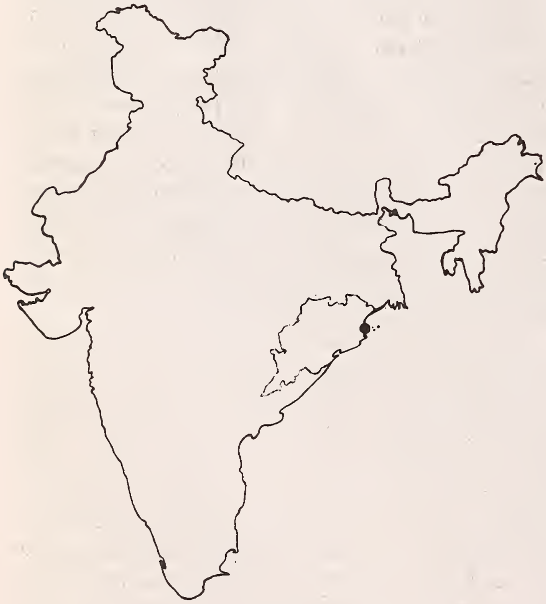

Fig. 1. Map of India showing location of Orissa and the Bhitarkanika Sanctuary (solid black circle).

## The Sanctuary

The Sanctuary, comprising 176 sq.km of Reserve and Protected forests, is located in the deltaic region of the Bitarani-Brahmani rivers in Cuttack District, orissa (Fig. 1). The habitat consists of deltaic mangrove swamps growing on rich alluvium. Some areas have been bunded for cultivation purposes, in all unbunded areas, however, mangrove vegetation is dominant.

Annual rainfall averages 1670 mm/annum with the main rainfall occurring during the monsoon months of August and September. In summer the temperature range is from the high 30°C to high 20°C (day and night respectively) whereas during the short winter it is upper 20°C to 15-20°C respectively. The mangrove habitat is intersected by numerous creeks and creeklets, the water flow in which is influenced twice daily by the tide.

The main mangrove species are *Avicennia alba* (a first coloniser), *Avicennia officinalis, Rhizophora mucronata, Excoecaria agallocha, Acanthus ilicifolius, Sonneratia apetala* and *Heritiera minor*. The palm *Phoenix paludosa*, the fern *Acrostichum aureum*, and *Hibiscus teliaceus* are widespread throughout the mangrove forests.

The human population of the Sanctuary and of the villages in the area adjacent to the Sanctuary totals 354,000, resulting in considerable encroachment problems.

The mammalian fauna includes the leopard (*Panthera pardus*), striped hyaena (*Hyaena hyaena*) and the lesser cats (*Felis chaus, F. bengalensis*); spotted deer (*Cervus axis*), sambar (*Cervus unicolor*) and wildboar (*Sus scrofa*). Large troops of rhesus macaque (*Macaca mulatta*) also occur in the Sanctuary. Both deer species, wildboar and macaques are taken by crocodiles (Kar and Bustard 1981). The larger reptiles include the Indian Python (*Python molurus*) and the monitor lizards (*Varanus salvator, V. flavescens* and *V. bengalensis*). The avifauna is rich and varied (Kanungo 1976).

## Methods

Winter was chosen for the survey as during the short winter in coastal Orissa, extending from late November to mid-February, the larger saltwater crocodiles bask regularly, whereas at other times of the year basking by these large individuals is reduced and sporadic (Kar 1981). Diurnal enumeration during basking is the only reliable method of censusing large crocodiles in the Sanctuary (see Discussion). Furthermore, during the winter, the postcrepuscular activity is telescoped into two to three hours following dusk allowing effective census of juveniles and immature year classes. Extensive field work in the Sanctuary has shown that night spotting is the effective method of censusing juveniles and subadult year classes (see Discussion).

Diurnal census was carried out during the basking hours each morning (0800-1100 hrs.) and night spotting between 1800 and 2100 hrs., at which time the crocodiles are likely to be present at the surface close to the bank in maximum numbers. During the day, it was a straight-forward matter to estimate the size of crocodiles sighted. Crocodiles of under 0.6 m do not bask and individuals of between 0.6-1 m could be estimated within 0.5 m. At night, using a powerful spotlight it is possible to approach light-blinded juveniles provided silence is maintained and experienced people control the boat and spotlight. However, only individuals of less than 2 m can be sighted at night with any regularity. Such individuals can usually be approached to within touching distance permitting at least as accurate size estimation as during the day. Adult crocodiles are very rarely seen during night spotting.

All census work here reported was carried out by boat, no other method being practicable due to the dense mangrove forest fringing the creeks. Local country boats used in the normal protection patrols within the Sanctuary were used for the census. These vessels are eight metres overall and are crewed by three boatman - two on the oars and one on the rudder. One of us (S.K.K.) operated the sealed beam, pre-focused spotlight as used by the Indian Navy and powered by a 12 volt car battery.

At night the tapetum of the crocodile's eyes reflect light enabling individuals floating at the water's surface (the normal alert posture after dark) to be sighted at distances of over 0.5 km with a powerful spot. The colour of the reflection enables an experienced observer to make a preliminary estimate of the size. The reflection of small crocodiles is pinkish in colour, becoming more reddish as the crocodiles grow. Very large crocodiles reflect a very dark red. However, all size estimates given in this paper were confirmed by close approach.

Familiarity with the habitat will greatly enhance the accuracy of survey results. We have intimate knowledge of the river and creek systems of the Sanctuary which are regularly patrolled using the same 'country boats' used in the actual survey work.

Survey in tidal rivers and creek systems, irrespective of whether they are conducted by day or by night, are greatly affected by the state of the tide. When the tide is high crocodiles will be missed:

(a) by day because the basking mudbanks will be inundated and any crocodile which has emerged will be within the vegetation zone where they are likely to be missed.

(b) at night because smaller crocodiles (less than2 m) usually remain close to the creek-banks. When the tide is high the reflection of their eyes may be hidden by overhanging vegetation and if the tide has flooded the bank these crocodiles may be in the vegetation zone itself.

In either situation the eye reflections are likely to be missed. Accordingly all surveys were carried out when the tide was half tide or less, that is when there was a drop of at least 1.6 m from the fortnightly high tide level.

In night survey work it is important to carry out the surveys during the darker phases of the moon. Nights on which work can be completed prior to the moon rising are best. When the moon is visible and there is little or no cloud cover, good results cannot be expected with a moon more than one-quarter full, since the spotlight is less effective under such conditions and the crocodiles are more likely to detect the approaching vessel (and hence not permit close approach).

Using the above techniques, it was readily possible to bring the dinghy to within 1.5 m or less of crocodiles of below three years of age (1.2-1.4 m) and to within 6 m or less of larger subadults.

There is no external sexual dimorphism in the saltwater crocodile. However, there is a marked difference in size between the sexes. Females do not exceed a total length of 4 m whereas males grow to in excess of 7 m and the average size of males within the Sanctuary is 5.5 m. All crocodiles in excess of 4 m were scored as males, and crocodiles in excess of 2.5 m but below 4 m scored as females. This method gives a much more accurate separation of the sexes

Table 1

CROCODILE POPULATION IN RELATION TO HABITAT. RIVER DISTANCES (KM), SEX OF ADULTS BRACKETED (M, F).

| Location | | Habitat Ranking | | | | Crocodiles Present | | | |
|---|---|---|---|---|---|---|---|---|---|
| Number | Length | River | Mangroves | Disturbance | Total | Adults | Sub-adults | Juveniles | Total |
| 1. | 6.2 | 1 | 1 | 1 | 3 | 0 | 2 | 1 | 3 |
| 2. | 12.4 | 3 | 3 | 3 | 9 | 2 (1M, 1F) | 0 | 3 | 5 |
| 3. | 7.8 | 3 | 3 | 3 | 9 | 2 (1M, 1F) | 0 | 15 | 17 |
| 4. | 7.5 | 3 | 3 | 3 | 9 | 4 (2M, 2F) | 0 | 10 | 14 |
| 5. | 8.7 | 2 | 2 | 2 | 6 | 1 (M) | 2 | 16 | 19 |
| 6. | 12.8 | 3 | 3 | 1 | 7 | 5 (3M, 2F) | 0 | 2 | 7 |
| 7. | 6.7 | 3 | 3 | 3 | 9 | 2 (1M, 1F) | 1 | 5 | 8 |
| 8. | 10.0 | 2 | 1 | 1 | 4 | 3 (2M, 1F) | 0 | 2 | 5 |
| 9. | 7.5 | 1 | 1 | 1 | 3 | 2 (1M, 1F) | 0 | 4 | 6 |
| 10. | 8.0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 |
| 11. | 1.5 | 2 | 0 | 1 | 3 | 1 (M) | 0 | 1 | 2 |
| 12. | 23.0 | 2 | 3 | 2 | 7 | 3 (2M, 1F) | 1 | 2 | 6 |
| 13. | 11.0 | 2 | 1 | 0 | 3 | 1 (F) | 0 | 0 | 1 |
| 14. | 7.5 | 2 | 2 | 1 | 5 | 3 (1M, 2F) | 0 | 0 | 3 |
| Total | 130.6 | - | - | - | - | 29 (16M, 13F) | 6 | 61 | 96 |

within the Sanctuary than might be anticipated, since as a result of severe hunting in the past, almost all the present adults are older individuals which have survived by becoming extremely wary. In the case of males, this means that they have attained a very large size.

Concurrent with the census, the major components of the habitat were evaluated. For the crocodiles, these are considered to constitute the river, the fringing mangrove forests, on which depends the creation of mudbanks for basking, as well as the cover so essential for young crocodiles and for nesting and the degree of human disturbance. These were scored 0 - 3. Where the river was very poor, the mangrove cover had been completely lost, or human disturbance was maximum, a score of 0 was given with an ascending score for progressively better habitats.

## Results

*The Crocodile Population*

Details of individuals recorded during the survey are given in Table 1 which also summarizes the results of the habitat evaluation discussed above. Although individuals between 0.8 and 2 m may represent six year classes, the majority of juveniles in the Sanctuary are the progeny of the 1974 and 1975 nesting seasons which have survived as a result of Sanctuary gazettement, especially the banning of set gill nets. The individuals referred to as juveniles in Table 1, totalled 61. Those in the 1.6 - 3 m size class comprise six subadult individuals (size range 1.6 - 2.1 m) together with individual considered to be a female. In the 3-4 m size class, it is thought that all are females. As described above, those in excess of 4 m are considered to be males. The presence of 11 individuals between 5-7 m, all of which are undoubted males, should be noted.

Table 1 indicates that adult males slightly exceed adult females numerically, that subadult (six) are very few in number, and that juveniles (61) account for more than 63.5% of the population, being more than twice as numerically abundant as adults.

The distribution of the population

The numbers refer to habitat areas (Figs. 2-4).

**Location 1:** This area is considered unsuitable for permanent residence by adults due to the excessive water flow (the left hand portion was a man-made cut dug to improve the water flow in the main river system and for easier transportation of goods). The mangroves are degraded on one bank.

Crocodiles present: Adult - 0, Subadults - 2, Juveniles -1.

**Location 2:** This creek system provides good habitat with good mangrove cover.

Crocodiles present: Adults -2 (one male and one female), Subadults - 0, Juveniles - 3.

**Location 3:** Good habitat. Very low human disturbance. Good mangrove cover.

Crocodiles present: Adults - 2 (one male, one female), Subadults - 0, Juveniles - 15.

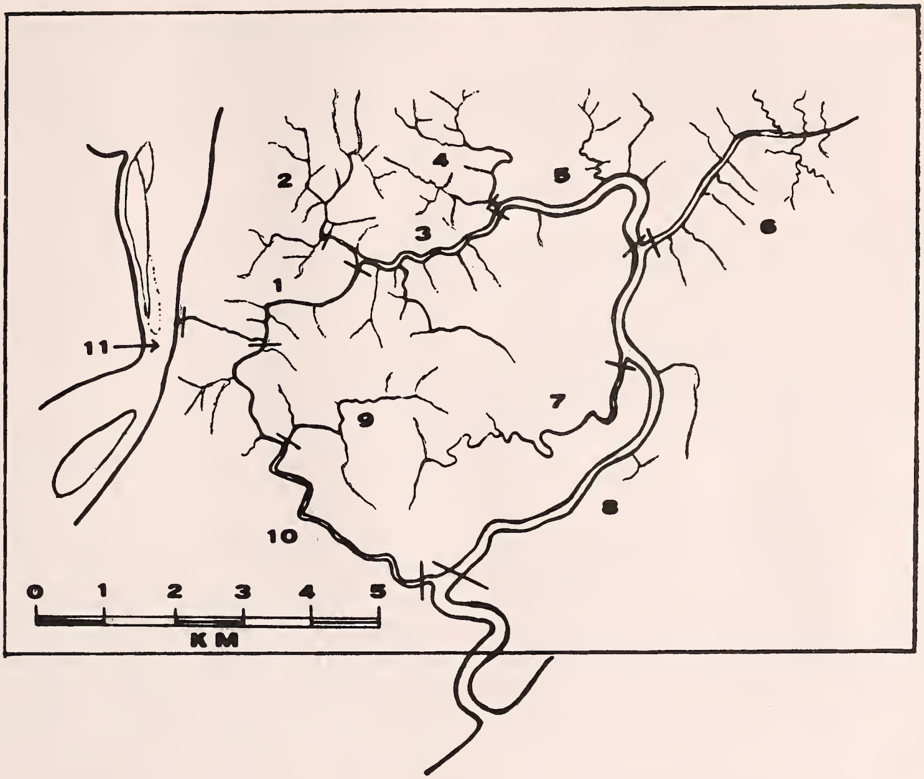

Fig. 2. The creek systems in the heart of the Sanctuary.
Location numbers refer to the text. The lines bisecting the creeks indicate the limits of each numbered location.

**Location 4:** Very good habitat with excellent mangrove cover. Low human disturbance.

Crocodiles present: Adults - 4 (two males, two females), Subadults - 0, Juveniles - 10.

**Location 5:** Good habitat. Good mangrove cover, especially on interior side. Some human disturbance.

Crocodiles present: Adults - 1 male , Subadults - 2, Juveniles - 16.

**Location 6:** Excellent habitat, good mangrove cover. Some human disturbance.

Crocodiles present: Adults - 5 (three males, two females), Subadults - 0, Juveniles - 2.

**Location 7:** Very good habitat, good mangrove cover. No human disturbances.

Crocodiles present: Adults - 2 (one male, one female) Subadults - 1, Juveniles - 5.

**Location 8:** Habitat no longer good. Mangrove cover totally absent on outer bank and on interior bank is poor. Substantial human disturbances.

Crocodiles present: Adults - 3(two males, one female), subadults - 0, Juveniles - 2.

**Location 9:** Habitat now poor due to high level of human disturbance. Mangrove cover becoming degraded. At low tide water depth is very low.

Crocodiles present: Adults - 2 (one male, one female), Subadults - 0, Juveniles - 4.

**Location 10:** Habitat poor since the river system is dry at low tide. Mangrove vegetation absent on outer bank and poor on interior. Much human disturbance.

Crocodiles present: No crocodiles of any size class.

**Location 11:** This area no longer offers any good habitat. Substantial human disturbances with cultivation right to river bank.

Crocodiles present: Adults - 1 (Male), Subadults - 0, Juveniles - 1.

**Location 12:** River habitat good. Excellent

mangrove cover. Low human disturbance.
Crocodiles present: Adults - 3 (two males, one female), Sub- adults - 1, Juveniles - 2.

**Location 13:** Good river habitat spoiled by maximum human disturbance and with poor mangrove cover.
Crocodiles present: Adults - 1 (female), Subadults - 0, Juvenile - 0.

**Location 14:** Good river. Northern bank completely denuded of mangroves with much illicit felling on the southern bank. The reserve forest of Kalibhanjadian has been subject to heavy illegal felling. Human disturbance high, particularly on the northern bank which has been developed into a fishing port. Disturbance on Kalibhanjadian Island is much less.
Crocodiles present: Adults - 3 (two females, one male), Subadults - 0, Juveniles - 0.

The above information is summarized in terms of habitat ranking of the river, mangroves and degree of disturbance in Table 1. Table 2 gives the density of the total crocodile population (number/km) in their fourteen areas of the Sanctuary. The crocodile density varies from 0/km to 2.18/km (mean 0.87). This is an extremely low figure (see Discussion).

TABLE 2
NUMBERS AND DENSITIES OF CROCODILES IN THE VARIOUS HABITATS. DISTANCES (KM), DENSITY/KM.

| Location | | Crocodiles | |
|---|---|---|---|
| Numbe | Length | Total Number | Density |
| 1. | 6.2 | 3 | 0.48 |
| 2. | 12.4 | 5 | 0.40 |
| 3. | 7.8 | 17 | 2.17 |
| 4. | 7.5 | 14 | 1.86 |
| 5. | 8.7 | 19 | 2.18 |
| 6. | 12.8 | 7 | 0.54 |
| 7. | 6.7 | 8 | 1.19 |
| 8. | 10.0 | 5 | 0.50 |
| 9. | 7.5 | 6 | 0.80 |
| 10. | 8.0 | 0 | 0 |
| 11. | 1.5 | 2 | 1.33 |
| 12. | 23.0 | 6 | 0.26 |
| 13. | 11.0 | 1 | 0.09 |
| 14. | 7.5 | 3 | 0.40 |
| Total | 130.6 | 96 | 0.87 |

## DISCUSSION

The topics for discussion fall into four main categories (1) survey techniques, (2) the crocodile population, (3) the distribution of the population in relation to habitat, and (4) implications of the above three topics for/in management of this crocodile Sanctuary.

### 1. Survey Techniques.

The techniques used here, are based on Bustard's 15 years' experience of *C. porosus* in the Asian/Pacific region with suitable modifications for local conditions. The survey was more intensive than those reported previously by Bustard (1967 : 1970) or those of Messel *et al.* (see Introduction). This was possible since the area studied is relatively small and has been the subject of continuous monitoring since 1975.

It was found that effective census of this population of saltwater crocodile required a combination of diurnal and night-spotting techniques.

Either approach by itself did not give an adequate census figure of both the adult and the juvenile/subadult components of the population. In Bhitarkanika, in the case of large crocodiles, the eyes are not even observed at a distance during night surveys. This is because adults have learned to submerge immediately they hear the sounds of a boat or see a light (even before the light strikes their eyes). This reflects learning (Bustard 1968), as a result of experience gained during previous human hunting activities. So, although night-spotting gives a much better guide to the number of immature crocodiles present ( m) than during day-spotting, the latter is the only way to census the adult cohort of the population.

At night all large adults come into the "eyes only" category of Messel *et al.* We feel that Messel's workers could get much more reliable data on large animals - both on their numerical abundance and their size (that is detailed clarification of the "eyes only" category, which in some of their surveys form an important part of the whole) - by using combined data from day and night censuses as carried out here. Furthermore, it is important to standardize not only the methodology of the census but also the time of the year of censusing, if subsequent recensuses are to be compared with the original census data in any meaningful way. We recommend carrying out the censuses only during winter (as done here) at the time of maximum basking by large adults and at a time when evening activity is concentrated into a

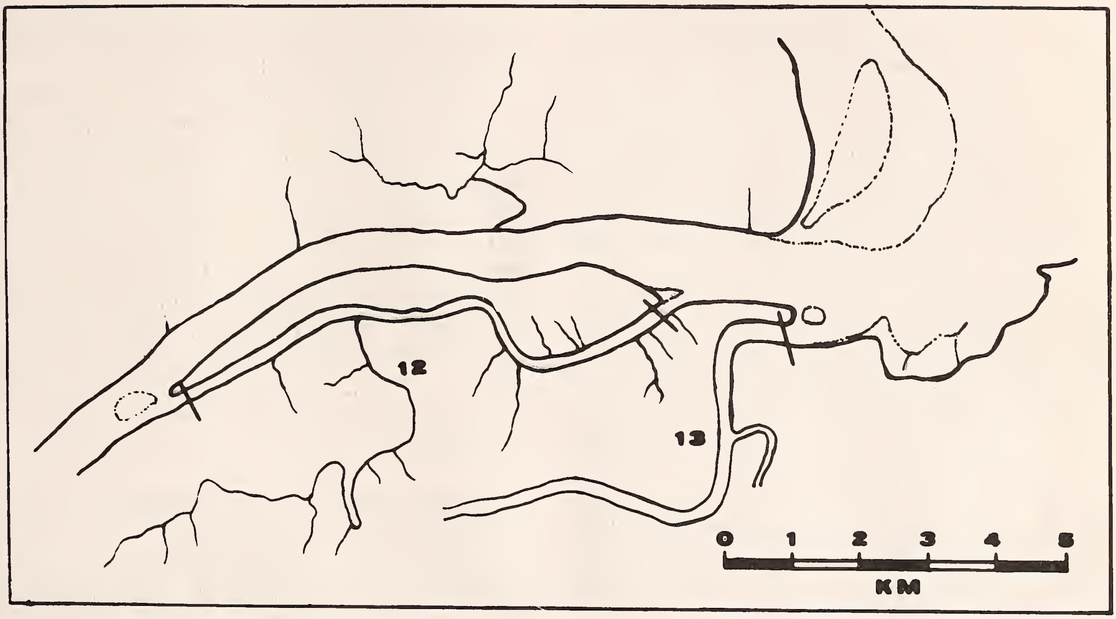

Fig. 3. Larger river systems towards the coastal side of the Sanctuary. Location numbers in the text.

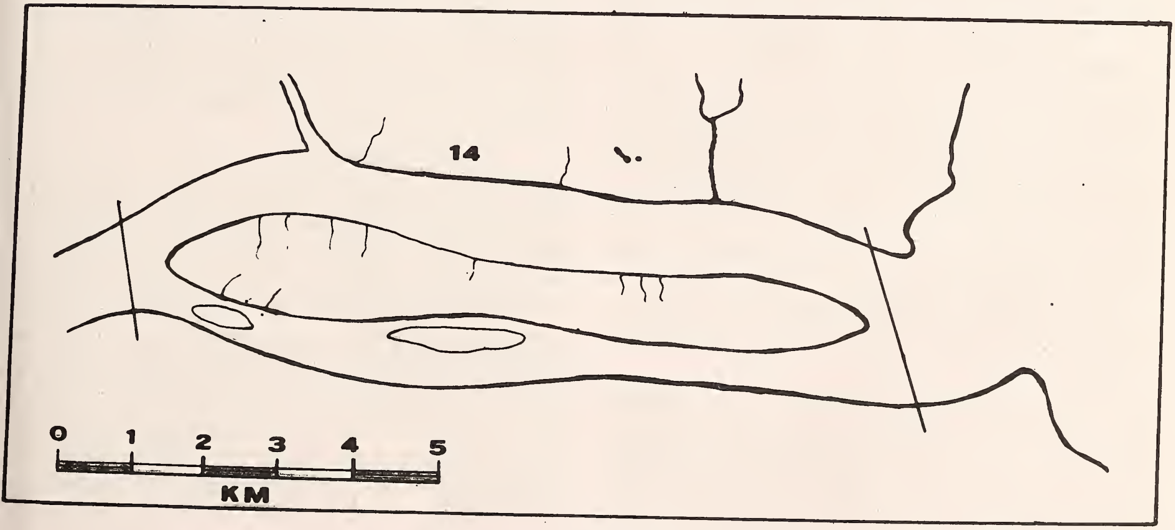

Fig. 4. The major river system at the extreme north of the Sanctuary. Location number in the text.

narrow time span probably resulting in more total coverage of the available population.

We also stress that increased population counts could well result from intimate familiarity with the habitat, and that phase of the moon *per se* (that is the effect of moonlight as opposed to the moon's effect on the tides) is important. Surveys should ideally be carried out in the dark phase of the moon or when the moon is less than full. We agree with Messel *et al* that proper counts cannot be carried out at high tide when the water has overflowed the bank and is in the vegetation zone. We operate only when the water is at least 1.6 m below the fortnightly high tide level whereas Messel *et al* do not commence survey until the water level has dropped 60 cm below a hypothetical line demarcating vegetation for the exposed mudbank. This hypothetical line is placed so that approximately as much vegetation remains below as mud is exposed above it.

Due to the intensive nature of the study being conducted at Bhitarkanika we are able to check and fully corroborate the survey data on the basis of regular basking sightings, nesting female numbers etc.

## 2. Crocodile Population.

The population is characterised by a numerical excess of males over females (16 as compared to 13). Under natural conditions (a population without a recent history of hunting) we would expect 16 adult males to be associated with at least 30 breeding females. The paucity of females in Bhitarkanika is thought to reflect differential human predation on females as compared to males. Females are readily killed at the nest (Bustard 1967, Bustard and Choudhury 1980, 1981). As mentioned above, at other times the adults are very vary, making capture extremely difficult as hunting methods in this area prior to its gazettement as a Sanctuary were by torch at night.

The number of subadults (six) is extremely low. This is considered to reflect very high loss levels of 2-3 years old as a result of use of set gill nets in this area until recently. This practice was stopped at the time of Sanctuary declaration when a total ban was placed on fishing within the Sanctuary (May 1975, see below). The population of juvenile *porosus* (mostly in their second and third years) has increased many-fold as a result of good survival of the 1974 and 1975 hatching year classes following cessation of fishing (see Section 4 and Kar 1981). This should result in greatly enhanced survival of subadults in the future, particularly since the adult population is numerically so depressed.

The overall abundance in the numbers of *C. porosus* (other than hatchlings) in Bhitarkanika at 0.87 individuals/km is of a similar order to the data of Messel *et al.* (see for instance Monographs 3, 4, 5 and 7). Since these figures are enhanced by approximately 50% by better recruitment of juveniles, the figures prior to commencement of management of the Sanctuary must have been approximately 0.4 km. Messel, Gans, Wells & Green (1979) gave comparable figures of respectively 0.48 and 0.55/km for the Victoria and Fitzmaurice rivers of the Northern Territory of Australia.

## 3. Distribution of the population in relation to the habitat.

If the three habitat criteria of the river, the mangroves and disturbance are examined together the correlation between the apparent 'health' of the habitat and the density of crocodiles/km (total figures for all size classes) is not well marked. There was a good correlation between river characteristics and density (Table 1), as would be expected. There was also some correlation between the degree of disturbance and crocodile population density. There was no apparent correlation between crocodile density and mangrove cover.

Examining the number of adults in relation to the habitat ranking, it was found that a low habitat ranking was associated with a low number of adults/habitat. However, when the habitat ranking was high the number of adults/habitat could be either high or low. One possible explanation for the persistence of adults in poor habitat areas would be that they took up their present home range when the non-river components of the habitat were much different from what they are today. The habitat changes, as they affect the mangrove forests and degree of disturbance have changed drastically in the last two decades, which probably reflect a short time span in the life of an adult saltwater crocodile. For examination of the data for juveniles showed a close agreement with that for adults which may be anticipated since juveniles can only occur in the presence of adults and dispersal to more favourable habitats had not occurred in this size class. Unfortunately the extremely limited number of subadults (six) precludes correlation analysis of their presence with habitat factors. It should be noted, however, that of the six subadults two occurred in location 1 in the absence of any adults and a further two in location 5 in the absence of any adult females. The remaining two occurred in separate habitats where there were one male and one female and two males and one female respectively. Thus their recruitment may perhaps be enhanced in the absence of adults, particularly females. However, due to the very low number of subadults this can only be conjecture at this stage.

### 4. Implications of the above three topics for management of this crocodile Sanctuary.

The total crocodile population is very low. The adult cohort of the population is miniscule. There are virtually no subadults. The only hope for the population lies in the survival of the present young crocodiles and their recruitment to the breeding population combined with the release of captive-reared crocodiles back into the wild when they have reached a size at which they are safe from most potential predation in order to boost this recruitment. Hence, if the crocodile population is to survive, let alone recover, both the habitat and the crocodile will require very rigid protection together with the removal of all inimical factors (see Recommendations).

There is a sexual imbalance in the small population of adult crocodiles, resulting in the need to build up the female cohort of the population. This is being done by releasing mostly young females from the Dangmal Centre (Kar and Bustard, in prepn.)

Survival prognosis for the immature crocodiles, resulting from both natural recruitment and release from captivity, is now good as a result of the banning of nylon gill nets throughout the Sanctuary. This is borne out by the sighting of no less than 61 crocodiles in the 1-1.5 m size class within the Sanctuary (Kar and Bustard, in prepn.). These individuals represent the hatching predominantly of the 1975 year class and to a lesser extent 1974. The virtually complete loss of the previous year classes as a result of their capture in fishing nets prior to banning of fishing throughout the Sanctuary in April 1975 should be noted. Whereas the six subadults represent at least six year classes indicating a survival of the order of only one per year, the 61 individuals represent only two year classes indicating a survival of about 30 individuals /year, an increase of 30 times over the previous figure when nylon gill nets were in use. The implications of this in management are obvious - it is essential to retain the legal ban on fishing in the Sanctuary and to ensure that under the new management plan this ban is effectively enforced throughout the Sanctuary.

The habitat degradation which has taken place may not yet be fully reflected in the numbers of adult crocodiles present as there is likely to be a time lag in that existing crocodiles continue to inhabit their traditional home range however degraded. It may not be possible, however, for new recruitment to take place under such conditions. Hence the situation facing the saltwater crocodile population of the Sanctuary may be even more critical than it appears.

## RECOMMENDATIONS

1. The ban on the use of set gill nets throughout the Sanctuary should be maintained.
2. No further encroachment on the mangrove habitat within the Sanctuary should be permitted.
3 This Sanctuary, as a unique floral/faunal ecosystem, should be declared as a Biosphere Reserve by the Government of India.

## ACKNOWLEDGEMENTS

We wish to express our thanks to the Orissa Forest Department, the Government of India, F.A.O. and U.N.D.P. for assistance.

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# MONKEYS OF THE OLD CITY OF JAIPUR, INDIA[1]

REENA MATHUR, R. MANOHAR AND A. LOBO[2]

(*With two text-figures*)

This report presents preliminary data on the density of *Macaca mulatta* and *Presbytis entellus* based on road transects in the city of Jaipur, India. The sampled area covered 7.8% of the total area of the old city of Jaipur. Transects were run during the morning hours of the winter season. The results indicate a much higher density of *Macaca mulatta* than of *Presbytis entellus* (346.4 and 36.6 per sq. km respectively). The number of rhesus groups in 7.26 sq. km is 21, while that of langurs is 5. The higher density of *M. mulatta* is attributed to its omnivorous and terrestrial habits. *P. entellus* is folivorous and arboreal; its habitat requirements are best met in the city's outskirts. In the old city they are mainly found in the temple areas. This investigation suggests that the monkeys in the inner old city should be managed by rehabilitation into the forest before they outstrip food supply and living space, and before they are treated more and more as pests by city inhabitants.

## INTRODUCTION

The present study is the outcome of a longfelt desire to take up census survey of primates of a city which has an abundance of two monkey species.

Monkeys are abundant in Jaipur, but there are very few reports on their population density and structure (Prakash 1962, Wolfe and Mathur 1987). The present investigation (October 1985 to February 1986) was initiated to provide preliminary information on the density of *M. mulatta* and *P. entellus* within the city.

## STUDY AREA

The city of Jaipur (26°55'N and 70°55'E) lies within the semi-arid zone. The climate is sub-tropical and characterized by three distinct seasons, with almost all rain falling from July to September, the annual rainfall being 70 cm. The winter season extends from October to February with temperature dropping to about 4°C. The summers are dry and hot, and temperatures may reach as high as 45°C. The total city area (urban agglomeration) is 210.09 sq.km and has a human population of 1,015,160 (density 4832 per sq.km). The city is divisible into an inner old city and a surrounding new city. Of particular interest in the present investigation is the old city which encompasses an area of 7.26 sq. km and has a high human density (33,480 per sq.km). This area has markets, tourist spots and residences.

For this study, ten roads were selected as the sample for density estimates in the old city (4 east-west, 6 north-south; Fig. 1). These roads were selected as transects because of the ease with which the monkeys could be counted. Hence the sample is not entirely random. Each transect was 1 km long (total 10 km). All transects except the sixth had a fixed width. Their widths were estimated by taking into account (i) width of the road, (ii) width of the pavements on both sides of the road, (iii) width of the shops on both sides, and (iv) parts of houses seen beyond the shops. Transect 6 was of the same length as the others but on each trip the transect width was determined by estimating the perpendicular distance of the animal farthest from the road. The mean value of all these widths provided the approximate width of transect 6. The area of each transect was calculated by multiplying transect width by length. The sampled area covered 7.83% of the total area of the old city (7.26 sq km).

## METHODS

Each transect was run 20 times at a fixed time of the day (0630 hrs.). The direction of movement along each of the transects was the same during all visits. On each survey the investigators drove along these road transects on a two wheeler (monkeys here are habituated to all urban noises) at slow speed (15 km/hour), stopping whenever there were monkeys to count, individuals and groups of both species. All precautions were taken not to count any individual twice. The following sequence of transect censuses was followed: transects 1, 5, 8, 2, 6, 9, 3, 7, 10, 4

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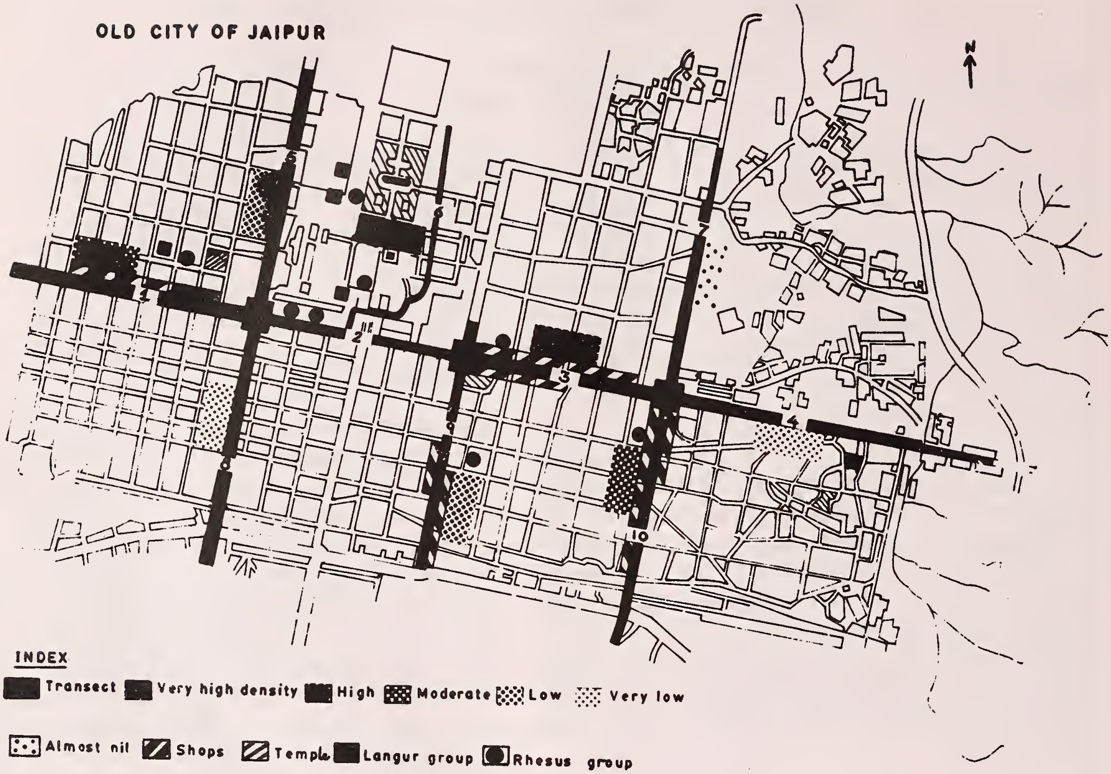

Fig. 1. Distribution and density of monkeys along the transects and its association with provisioning sites.

(Fig. 1). This sequence was established to avoid the possibility of counting individuals twice and was based on a consideration of the movement of monkeys along the transects. Collectively, the transects covered a total area of 0.57 sq.km (56.94 ha). This method provided a quick estimate of primate density in the study area. The total survey time was 160 man hours; the cumulative transect length was 200 km, and the total survey area was 7.26 sq.km.

Driving a vehicle slowly on the road is probably the best way to census monkeys in the city. Monkeys sometimes keep moving rather rapidly in the same direction; if the transect is walked, monkeys may pass the investigator and be counted twice.

Long broad roads were chosen for the transects because on narrow, congested lanes the houses are very close and monkeys easily jump from one house to another and even from one lane to another,thus increasing the chances of counting the same monkey twice. Morning hours during the winter months are the best time to count monkeys in Jaipur because most individuals are huddled together and sit basking on the rooftops.

## RESULTS

The total density of monkeys in the old city of Jaipur is 383.0/sq.km. Langurs contribute a very small fraction to this total, i.e. 36.6/sq.km. The remaining 356.4 is constituted by rhesus monkeys alone (relative density 0.12 and 0.88 respectively).

Twenty-one rhesus and five langur groups were encountered and identified. Biomass calculations show that mean weight per sq.km for langurs is 522 kg while for rhesus it is 3117.6 kg (X wts. Prater 1980, Napier and Napier 1967). This suggests that, within the inner city, food is much more utilized by rhesus than by langur. Whether calculated on the basis of number of individuals or biomass per sq.km., rhesus are clearly dominant in the inner city.

The maximum mean number of rhesus and langurs (175.3 ± 14.3 and 34.6 ± 2.2 respectively) was found in transect 6. Rhesus were seen in all 10 transects, whereas langurs were absent in transects 5, 7, 9 and 10 (Fig. 2).

Therefore, the frequency of sighting langurs is as low as 0.6 and that of rhesus is 1.0. If transect 6 is excluded from the analysis, density estimates are reduced from 383.0 to 278.5 monkeys/sq. km. (262.1 rhesus/sq.km and 16.4 langurs/sq.km). Transect 6 is the only transect which includes a temple, where people not only protect animals but also feed them.

## DISCUSSION

The spatial distribution of *M. mulatta* and *P. entellus* in the city of Jaipur is distinct. The old city has a very high density of rhesus; though they are found all over the old city, their greatest concentration is in transect 6 because of the presence of a temple and a tourist spot in that area. The concentration of rhesus in the old city is attributed to their omnivorous, terrestrial feeding habits and more aggressive nature. They raid shops and pilfer goods from people. The distribution of langurs is restricted mainly to transect 6 (temple-tourist area) probably because more vegetation is found there (as compared to the rest of the old city). In brief, both species are most abdundant in temple-tourist area because of protection generally offered to them. In other areas of the old city the rhesus is found as mentioned earlier but sighting a langur group is rather rare. The shop keepers and vendors keep chasing monkeys away. The rhesus, which is more aggressive, withstands this, while langurs flee.

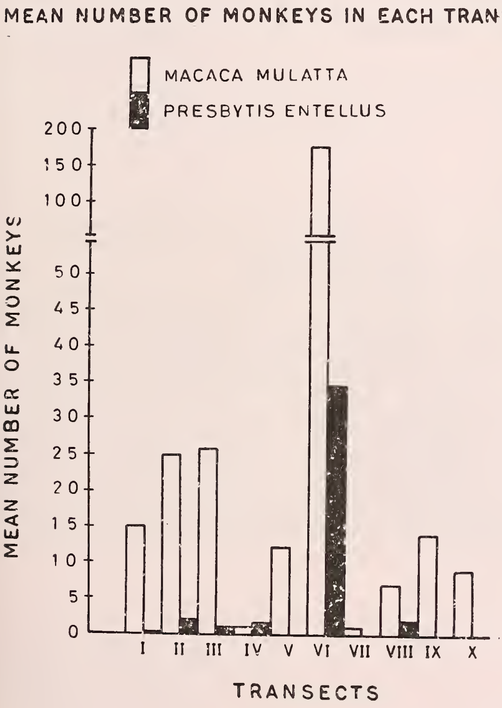

Fig. 2. Mean number of monkeys at each site.

The distribution and density of *M. mulatta* along the road transects has a close association with the wholesale fruit, vegetable, grain and jaggery shops (Fig. 1; Table 1). *M. mulatta* would often be found concentrated around these shops. The highest concentration of *M. mulatta* and *P. entellus* at transect 6 is probably due to the facts that (i) the transect passes through the area of a large temple where provisioning is high, (ii) there are few residential houses along this transect, so that monkeys are seldom chased or otherwise harassed, and (iii) the area has many trees to give refuge to both species and provide food to langurs. Otherwise, langur groups are generally seen on the city outskirts, probably due to two reasons: (i) there is virtually no confrontation with the more aggressive rhesus, and (ii) the outskirts provide more food (leaves, fruits etc) of the type eaten by the langurs.

After talking to inhabitants of the old city and completing the density study, the authors support suggestions made by Southwick and Siddiqi (1983, 1984) that excess numbers of monkeys should be translocated from areas of high human population. This is necessary to protect both the monkeys and the people from mutual harassment and reduce the potential of disease transmission (Mohnot 1978, Hall 1955) and also to reduce human influence on monkeys (Neomi *et al.* 1981).

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TABLE 1

DISTRIBUTION AND CONCENTRATION OF *Macaca mulatta* AND *Presbytis entellus* ALONG THE TRANSECTS AND ITS ASSOCIATION WITH PROVISIONING SITES

| Transect No. | Area | Habitat | Concentration of rhesus and langur |
|---|---|---|---|
| 1. | 0.048 sq.km<br>Chandpole to Choti Chopad | Jaggery, grain and vegetable markets; temple | Moderate |
| 2. | 0.048 sq.km<br>Choti Chopad to Badi Chopad | Tourist area | High |
| 3. | 0.048 sq.km<br>Badi Chopad to Ramgunj | Jaggery, vegetable and fruit markets | High |
| 4. | 0.048 sq.km<br>Ramgunj to Surajpole | No shops selling eatables | Very low |
| 5. | 0.044 sq.km<br>Choti Chopad to Brahampuri | No shops selling eatables | Low |
| 6. | 0.16 sq.km<br>City Palace to Govind Deoji | City Palace;<br>temple; high provisioning | Very High |
| 7. | 0.04 sq.km<br>Ramgunj to Char Darwaza | No shops selling eatables | Almost nil |
| 8. | 0.04 sq.km<br>Choti Chopad to Kishanpole | Few sweet shops | Very low |
| 9. | 0.04 sq.km<br>Badi Chopad to Johari Bazar | Vegetable and fruit markets | Moderate |
| 10. | 0.04 sq.km<br>Ramgunj Chopad to Ramgunj Bazar | Jaggery and grain markets | Low |

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# BIOLOGY OF THE PREDACEOUS BUG *RHINOCORIS MARGINATUS* FABRICIUS (INSECTA - HETEROPTERA - REDUVIIDAE)[1]

Dunston P. Ambrose[2] and David Livingstone[3]

(*With three text-figures* )

*Rhinocoris marginatus* Fabricius lays pale yellow eggs in batches in an orderly sequence. Eggs are glued to each other and to the substratum with cementing material. Sanguineous nymphs hatch from the eggs in 9 to 13 days. Stadial period from first instar to adult ranges from 68 to 115 days. Adult females live longer than males. Observations on laboratory-raised bugs for four generations indicate that the sex ratio of *R. marginatus* is not biased.

## INTRODUCTION

*Rhinocoris marginatus* Fabr. is an alate, entomosuccivorous, polyphagous, multivoltine, crepuscular, brightly coloured assassin bug occurring in the scrub jungles and semi-arid zones of peninsular India. It is not found in the adjacent tropical rain forests or on hillocks. It manifests as three different recorded morphs, namely niger, sanguineous and nigrosanguineous, and a number of ecotypes. The morphs are distinguished based on the colours of the connexivum (Ambrose 1980). This polyphagous bug is a predator on various insect pests like *Calocoris angustatus* Leth., *Cyrtacanthacris succincta* Kirby, *Dysdercus cingulatus* Distant, *Earias vittela* (Fb.), *E. insulana* Boisd., *Heliothis armigera* Hubn. and *Mylabris pustulata* Lefroy both in the laboratory and in field conditions.

Bioecology of a few species of oriental reduviids is known. They include *Coranus spiniscutis Reuter (Bose 1949); Rhinocoris lapidicola* Samuel and Joseph and *R. nysiphagus* Fabricius (Joseph 1959); *Lophocephala guerini* Laporte (Ambrose and Livingstone 1979); *Acanthaspis pedestris* Stal (Livingstone and Ambrose 1978) and *A. quinquespinosa* Fabricius (Ambrose 1983). The biological details presented here are related to a niger morph, collected from Kangayampalaya, a semi-arid zone of Coimbatore district, Tamil Nadu.

## MATERIAL AND METHODS

Adults of niger morph of *R. marginatus* were collected from Kangayampalayam semi-arid zone in Coimbatore District. They were reared in plastic containers (12 cm x 6 cm x 4 cm) on house flies, camponotine ants, carabid beetles and grasshoppers. The batches of eggs laid were reared separately in plastic containers with wet cotton swabs for maintaining optimum humidity (85%). The cotton swabs were changed periodically in order to prevent fungal attack. Observations on oviposition, incubation and stadial periods, nymphal mortality, adult longevity and sex ratio were recorded. Four generations were raised in the laboratory.

## RESULTS AND DISCUSSION

### **Microhabitat:**

Adults and nymphs of *R. marginatus* are found underneath stones and in crevices, but no parental care has been observed, unlike in other assassin bugs, viz. *Rhinocoris albospilus* Signoret (Odhiambo 1959) and *Zelus* sp. (Ralston 1977). Different species of Carabidae and Tenebrionidae, the common yellow scorpion (*Buthus* sp.), and on rare occasions venomous reptiles, such as *Echis carinata*, are also found in the same microhabitats. Very rarely, *R. marginatus* is found in pairs but not more than two adults are found at a time in the same microhabitat, even though up to five nymphs are found to congregate.

### **Oviposition pattern:**

*R. marginatus* deposits its first batch of eggs 33.33±2.87 days after imaginal moult. Eggs are laid in batches, each attached to the other and glued basally to the substratum with a gelatinous cement-

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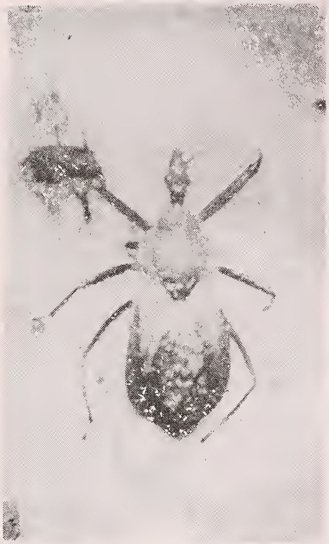

Fig. 1. Ovipositing *R. marginatus*

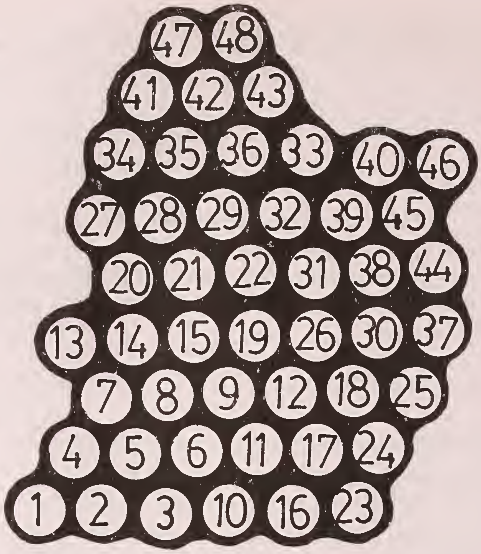

Fig. 2. Pattern of oviposition in *R. marginatus*

ing material. The eggs are pale yellow and cylindrical, with an operculum which is white, comb-like, highly reticulate and completely enveloped by a mantle of highly reticulate (hexagonal) collar that develops abruptly from the mouth of the egg. It very much resembles the egg of *R. olfugus* (Cobben 1968). The egg is 1.01 mm long, 0.463 mm wide, the operculum being 0.409 mm long and 0.363 mm wide. *R. marginatus* does not glue its eggs to fresh excreta unlike *Acanthaspis pedestris* and *A. siva* Distant (Ambrose 1980) and in *A. quinquespinosa* (Ambrose 1983). There is no seasonal influence on oviposition behaviour as reported in *Rhinocoris albospilus* (Odhiambo 1959) and *Zelus* sp. (Ralston 1977).

*R. marginatus* lays eggs in an orderly sequence (Figs. 1 and 2) as reported by Odhiambo (1959), Edwards (1962) and Swadener and Yonke (1973) in other species. The female selects an area free from foreign materials, and it remains at that particular spot with legs wide apart, wings slightly raised, pedicel and scape erect, with drooping flagellar segments. The genital segments alone move vertically up and down as the eggs are conveyed one after another. The non-opercular end of the egg comes out first with a little gelatinous cementing material. The egg is placed gently on the substratum with the tip of the genital segments one after the other by touching the available place by its abdominal tip nearer to the already deposited egg. In one instance (Fig.2) it took 41 minutes to lay 48 eggs at a stretch without taking any rest, requiring on an average 51.25 seconds for each egg. During oviposition the only movement is the up and down movement of the abdominal tip. The pattern of oviposition indicates that with one tilting of abdomen three eggs are laid in a particular direction. The entire oviposition pattern is somewhat zigzag in nature.

Table 1 summarises the oviposition pattern and hatchability rate of the bug. An index of oviposition days has been prepared by calculating the percentage of number of egg laying days during the adults' life-span. The unfertilized eggs are normal when laid but shrink after some days as in *Coranus vitellinus* Distant (Ambrose 1980). Neither the males nor the females of *R. marginatus* guard the eggs or show any parental care towards nymphal instars as reported in *Rhinocoris albospilus* (Odhiambo 1959) and *Zelus* sp. (Ralston 1977).

**Incubation and hatching:**

Under laboratory conditions (32°C, RH 80-85%, Photoperiod 11-13 hr) the eggs hatch in 9 to 13 days. Hatching usually takes place in the afternoon and very seldom in the forenoon. The nymphs do not probe the egg shell soon after eclosion as

TABLE 1
MEAN (18 ± SE) VALUES OF OVIPOSITION PATTERN AND VIABILITY IN *R . marginatus*

| | Range | Mean |
|---|---|---|
| 1. Adult female longevity in days | 111 to 129 | 120 ± 10.63 |
| 2. Age at which first batch of egg laid in days | 30 to 54 | 33.33 ± 2.87 |
| 3. Index of oviposition days | 2.33 to 10.58 | 9.22 ± 3.08 |
| 4. Total number of batches of eggs laid | 4 to 15 | 7.33 ± 2.47 |
| 5. Minimum number of eggs per batch | 1 to 14 | 9.80 ± 4.74 |
| 6. Maximum number of eggs per batch | 37 to 52 | 43 ± 6.72 |
| 7. Average number of eggs per batch | 20 to 28 | 22.36 ± 2.17 |
| 8. Total number of eggs laid | 110 to 280 | 154.67 ± 52.8 |
| 9. Total number of nymphs hatched | 78 to 114 | 88.33 ± 23.64 |
| 10. Hatching percentage | 58 to 71 | 66.9 ± 5 7.48 |

TABLE 2
MEAN INCUBATION AND STADIAL PERIODS IN *R. marginatus*

| Generation | Incubation period in days | Stadial period in days | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | I–II | II–III | III–IV | IV–V | V Male | V Female | I Adult |
| 1. | 10.51 ±<br>0.19<br>(77) | 22.83 ±<br>0.67<br>(12) | 14.9 ±<br>0.13<br>(12) | 14.08 ±<br>0.62<br>(12) | 15.25 ±<br>0.68<br>(12) | 24.22 ±<br>1.03<br>(12) | 27.33 ±<br>0.17<br>(9) | 93.83 ±<br>3.52<br>(3) |
| 2. | 8.74 ±<br>0.88<br>(19) | 20.77 ±<br>1.14<br>(13) | 16.62 ±<br>0.56<br>(13) | 14.61 ±<br>0.32<br>(13) | 19.15 ±<br>0.53<br>(13) | 29.0 ±<br>3.05<br>(13) | 31.1 ±<br>1.64<br>(13) | 102.08 ±<br>2.01<br>(10) |
| 3. | 9.80 ±<br>0.3<br>(21) | 18.87 ±<br>0.65<br>(15) | 13.00 ±<br>0.18<br>(15) | 15.62 ±<br>0.57<br>(15) | 21.07 ±<br>0.09<br>(15) | 35.0 ±<br>0<br>(15) | 36.2 ±<br>1<br>(5) | 105.93 ±<br>1.02<br>(10) |
| 4. | 9.19 ±<br>1.29<br>(65) | 15.67 ±<br>0.26<br>(59) | 12.42 ±<br>0.29<br>(59) | 12.42 ±<br>0.26<br>(59) | 18.1 ±<br>0.26<br>(59) | 36.35 ±<br>0.65<br>(59) | 33.92 ±<br>1.18<br>(28) | 96.9 ±<br>0.9<br>(31) |

(Figures in parentheses indicate the number of observed individuals).

reported for *Rhodnius prolixus* Stal. (Breecher and Wigglesworth 1944).

**Stadial period:**

It is interesting to report that both moulting and adult emergence occur only in the afternoons, corresponding to the eclosion periodicity. Table 2 summarises the stadial periods . As in *Coranus vitellinus* (Ambrose 1980), the stadial period of the third instar is the shortest and that of the final instar of the female the longest. The complete stadial period from first instar to adult ranges from 68 to 115 days.

**Description of the nymphal instars:**

Sanguineous; scape and pedical, dorsal surface of abdomen, wing pads, median band and lateral margins beneath the abdomen, apical half of femur, tibiae and tarsomeres black (Fig. 3).

Head finely pubescent with straight and clubbed hairs; transverse impression in between eyes; delimiting anteocular and postocular areas both similar in extent; four-segmented filamentous antenna, scape the longest, first flagellar segment the shortest; rostrum three segmented, terminal segment the shortest, middle segment the longest. Prothorax sanguineous and finely pubescent, width greater than length, median longitudinal impression both in the prothorax and pterothorax prominent; legs richly pilose and devoid of tibial pads, mid-tibia the shortest and hind-tibia the longest; abdomen longer than wide, 3 dorsal median inter segmental scent gland orifices located in between 3rd and 4th; 4th and 5th; and 5th and 6th abdominal segments.

**Nymphal mortality:**

The highest rate of mortality is recorded in the first instar (43.58%) followed by the second

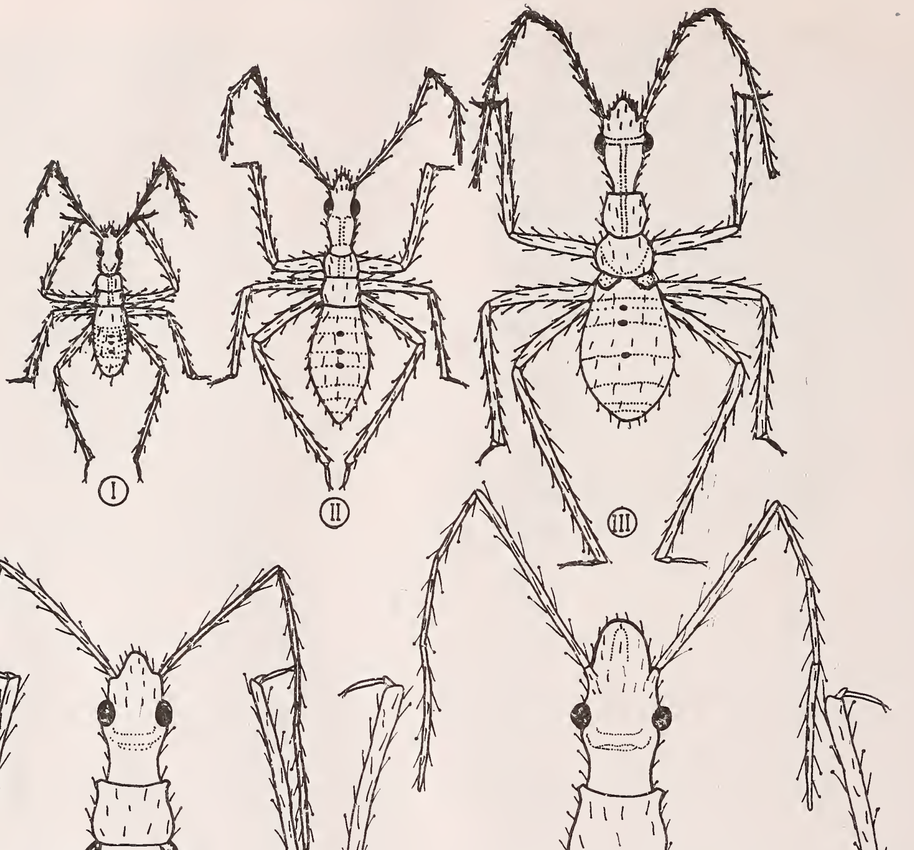
I
II
III
IV
V
5mm

Fig. 3. Nymphal instars of *R. marginatus.*

TABLE 3
MEAN ADULT LONGEVITY AND SEX RATIO IN *R. marginatus*

| Generation | Adult longevity in days | | Sex ratio | |
|---|---|---|---|---|
| | Male | Female | Male | Female |
| 1. | 20.2 ± 8.2 | 120 ± 10.63 | 1<br>(9) | 0.3<br>(3) |
| 2 | 19.67 ± 7.17 | 75.29 ± 8.82 | 0.3<br>(3) | 1<br>(10) |
| 3. | 18.6 ± 5.15 | 43.43 ± 12.84 | 0.5<br>(5) | 1<br>(10) |
| 4. | 29.71 ± 5.59 | 45 ± 7.14 | 0.9<br>(28) | 1<br>(31) |

(Figures in parenthesis indicate the number of observed individuals).

34.09%) and the fifth (20%). Third and fourinstars record 17.24% and 16.66% mortality respectively. As in other Harpactorine species (Ambrose 1980) the first instars fall easy prey to other co- instars and thus record the highest rate of mortality. Nymphal mortality is mainly due to the pronounced cannibalistic tendency among nymphal instars. Abnormalities and natural hazards in hatching, moulting, combat against powerful prey etc. are a few other causes of nymphal mortality.

**Adult longevity and sex ratio:**

The life span of adult males is very short when compared to that of females (Table 3). *R. marginatus*is multivoltine. Sex ratio of males and females was 1:0.3, 0.33:1, 0.5:1 and 0.91:1 respectively in the first, second, third and fourth generations raised in the laboratory.

## ACKNOWLEDGEMENTS

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## KEY TO NYMPHAL INSTARS:

1. First flagellar segment half as long as the pedicel, second flagellar segment twice as long as the pedicel; basal segment of rostrum less than twice the length of terminal segment; wing pads notdeveloped........................................................................(2)

First flagellar segment more than half the length of pedicel, second terminal segment less than twice the length of pedicel; basal segment of rostrum more than twice the length of terminal segment; wing pads developed ............................................(3)

2. Both anteocular and postocular areas (independently) equal to the width between eyes in length; diameter of eyes half of the width between eyes; terminal segment of rostrum half as long as its basal segment................................................FIRST INSTAR

Both anteocular and postocular areas (independently) more than width between eyes in length; diameter of eyes more than two thirds of width between eyes; terminal segment of rostrum two thirds of basal segment in length..........SECOND INSTAR1

3. Scape thrice the length of the first flagellar segment, wing pads not reaching abominal segents.........................THIRD INSTAR

Scape less than thrice the length of first flagellar segment,wing pads reaching abdominal segments ........................................ (4)

4. Postocular area slightly longer than anteocular area, first flagellar segment two thirds of pedical length, wing pads reaching first abdominal segment, width of abdomen two thirds of its length.........................................................FOURTHINSTAR

Postocular area shorter than anteocular area, first flagellar segment almost equal to that of pedical, wing pads extending beyond 3rd abdominal segment, width of abdomen less than two thirds of its length.....................................................FIFTH INSTAR

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# A CONTRIBUTION TO THE BIOLOGY OF HOUBARA BUSTARD: 1983–84 POPULATION LEVELS IN WESTERN BALUCHISTAN[1]

AFSAR MIAN[2]

*(With a text-figure)*

The analysis of 6 quadrats in western, 2 in central, 6 in eastern Chagai and 13 in Kharan administrative districts (Baluchistan, Pakistan) suggested that in the latter half of February 1984 the density of the Houbara Bustard (*Chlamydotis undulata macqueenii*) was highest in western Kharan (1.1125 birds/km$^2$), followed by eastern Chagai (0.4375), central Chagai (0.3438), eastern Kharan (0.1250) and lowest in western Chagai (0.0208). The quadrat data suggests that there are still some 15,000 - 20,000 birds wintering in Baluchistan.

## INTRODUCTION

The flat, open, desolate valleys of western Baluchistan with loose sandy background and optimal sparse distribution of shrubs are known to harbour a good wintering population of the Asian race of the Houbara Bustard, *Chlamydotis undulata macqueenii* (Ali and Ripley 1969, Anonymous 1972). Our previous studies have tended to suggest that this region harbours a comparatively rich population of the bustards, as compared with various other known populations of such a large bird (Mian and Surahio 1983, Mian and Rafique 1984, Mian and Dasti 1985). We did attempt to develop a map of the region depicting the tentative relative concentration, depending upon the hunting successes of the Arab falconers (Mian 1984). However, no scientific survey of the population levels has been undertaken. This paper attempts to report the results of a partial and preliminary survey of this bustard species in certain favourable areas, which are known to hold a sizeable population of this species, specially in Chagai and Kharan districts.

## MATERIAL AND METHODS

A survey of the favourable areas in Chagai, i.e Nokkundi (28° 85'N, 62° 76'E), Yakmuch (28° 79'N, 63° 90'E), Padag (29° 03'N, 65° 14'E) and Nushki (29° 56'N, 66° 06'E); andKharan, i.e., Jalwar (28° 53'N, 64° 92'E) and western Kharan (28° 33'N, 65° 00'E), districts was undertaken in the latter part of February 1984. The quadrat method was employed in all these areas in order to find the population levels of the Houbara Bustard. A party of three workers (the author along with two prominent local hunters of the area) travelled in a jeep for a predecided distance of 16 km, at a moderate speed (15–25 km per hour), tending to maintain a straight line. Each looked for the bird in a predecided direction, so that a maximum band was covered efficiently. Whenever one of us spotted a Houbara Bustard, it was almost immediately reported to the others. Generally, on spotting the jeep in the vicinity of the located bird, all the birds present around in an area of 200 m would take to their wings. These flying birds were easily counted. It was believed that by this technique, on an average, a band of some 500 m could be covered efficiently. Thus, the calculations regarding the density of the Houbara present in a quadrat was based upon the assumption that each quadrat covered an area of some 8 km$^2$ (16 x 1/2 km). Different numbers of quadrats were studied in different areas in accordance with the total area of the favourable tract and the time at our disposal. Each quadrat area was at a distance of half an hour's free drive from the finish point of the last quadrat area. The overall density of the bird population, in an area was calculated by pooling the data of all the different quadrats in the specific area. Sokal and Rohlf (1969) were followed for statistical analysis.

The observations on the three quadrats were carried out starting soon after sunrise upto 1100 hrs. and on two/three from 1600 hrs. till a little after sunset, with the assumption that during these comparatively cooler parts of the day, the birds would be out of their roosting places, picking up food in the field, thus providing a greater chance of seeing all the birds present in the area.

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A selected number of the hunters, shepherds and nomads in each of these areas were also interviewed. They were questioned regarding the number of the birds seen during the last few days and the approximate distance travelled for such an observation. It was believed that a casual observer could observe the presence of the bird in a band of some 200 m. The records were, however, maintained as a check to our observations, and were never subjected to a detailed analysis. Our quadrat data generally agreed with the observations of the local populace.

## RESULTS

Table 1 presents the data regarding number of birds observed, and the calculated population density, in each of the quadrats studied in Chagai and Kharan districts. The table indicates that the population density of the Houbara Bustard is very low in otherwise quite favourable tracts of the western region of Chagai, i.e., Nokkundi and Yakmuch. The overall density of the bird population, calculated from six different quadrats examined in the region, is worked out to be 0.0208 birds per km$^2$. These observations were corroborated by the fact that, despite our best efforts, we could spot footprints of the bird at only four places. Further, the information from the local hunters and shepherds also indicated that they had hardly seen a bird in the area since January 1984. The data obtained from the two other quadrats, in the central Chagai, i.e., Padag, indicated that there was an adequate population of the Houbara, with a calculated density of 0.6875 birds per km$^2$.

The quadrat data seems to be rather an overestimation of the actual bird population density in the area, as small plains with almost equal areas under hilly terrain are alternately distributed in this region. We could spot many foot-prints on the loose soil present in almost all the dried water courses scattered in the hilly terrain, and we are of the opinion that almost all the birds move to the hilly terrain during the hotter part of the day, coming out into the plains for picking up food during the morning and evening. Thus our quadrat data, collected in the evening session from the plain areas would include the birds which are actually dispersed in both hilly and plain areas. In the light of these facts, a reasonable estimate of the population of this bird would be half of the one obtained through our quadrat analysis. Hence the overall population density of the bird in this area comes to about 0.3438 birds per km$^2$. The favourable tract of the eastern Chagai, i.e. Nushki, bears a reasonable population density and the pooled data obtained from six different quadrats analysed in the area suggest an overall density of 0.4375 birds per km$^2$. The major part of the population of the eastern Chagai is the migratory flock, which is at this part of the year on a return migration towards their summering grounds.

Table 2 presents a reasonable estimate of the Houbara Bustard, expected to be present in different areas of Chagai and Kharan. The presently available information suggests that, towards the latter part of February 1984, some 14,840 birds were present in the area of Chagai and Kharan, permitting a reasonable guess that some 15,000 birds are present in these two districts and their adjacent areas.

Different quadrat areas are remarkably different from one another with regard to the topography, background soil and the general vegetation. Generally, all these areas bear loose background soil with sandy or loose stony cover. All these areas are flat, with different degrees of scattered sand dunes or small hills. The vegetation of these plains can be regarded as wasteland steppe, having scattered shrubs of *Haloxylon ammodendron, Anabasis* sp., *Pennisetum dichotomum, Calligonum comosum, Koehleria phloeoides*and *Ephedra*sp., which are distributed to varying degrees in the different areas. Persistent drought in the western Chagai had stopped the sprouting of shrubs, annual herbs and grasses. However, a moderate precipitation during the winter months has caused a reasonable vegetation in the central and eastern Chagai as well as in Kharan. It was believed that the Houbara was attracted towards the wheat fields during the night and we could confirm the presence of a single bird in the wheat field at about 2100 hrs. However, it could not be confirmed whether the Houbara does consume parts of the wheat plant or is attracted to some associated vegetation or insects.

## DISCUSSION

The results of the quadrat data collected from the different areas of Chagai and Kharan suggest that towards the latter half of February 1984,

TABLE 1

OBSERVED NUMBERS AND CALCULATED DENSITY OF THE HOUBARA BUSTARD IN DIFFERENT QUADRATS (8 KM2 )IN CHAGAI AND KHARAN DISTRICTS (BALUCHISTAN, PAKISTAN), AS STUDIES IN FEBRUARY, 1984

| General Area | Approximate Location of quadrat | Number of birds observed | Calculated density (birds/km2 ) | Overall calculated density in general area (birds/km2+ s.e) |
|---|---|---|---|---|
| Nokkundi | Koh-i-Sultan | — | 0.00 | |
| Yakmuch | Gut Game Reserve | — | 0.00 | |
| (Western | Non Reserved area | — | 0.00 | 0.0208 ± |
| Chagai) | Ghala Chah | 1 | 0.125 | 0.0208 |
| | Gonnakoh | — | 0.00 | |
| | Dalbandin | — | 0.00 | |
| | Dalbandin | — | 0.00 | |
| Padak | Masseti Railway | — | | |
| (Central | Landi | 6 | 0.75 | 0.6876 ± |
| Chagai) | Pul Chotao Dak | 5 | 0.625 | 0.0616 |
| Nushki | Dak (Zanghi Nawar) | 2 | 0.25 | |
| (Eastern | | | | |
| Chagai) | Inam Bostan Dak | 4 | 0.50 | |
| | Jal Kilghi | 5 | 0.625 | 0.4375 ± |
| | Amir Dal | 3 | 0.375 | 0.0089 |
| | Amir Dal | 3 | 0.375 | 0.0089 |
| | Amir Dal | 4 | 0.500 | |
| | Amir Dal | 3 | 0.375 | |
| Kharan | Kissan Pat | 7 | 0.875 | |
| (Western, | Bengalzai | 9 | 1.125 | |
| high density | Garruk | 8 | 1.000 | |
| area) | Tagab Dal | 4 | 0.500 | 1.1125 ± |
| | Tagab Dal | 3 | 0.375 | 0.1692 |
| | Bedi | 6 | 0.750 | |
| | Chinie | 10 | 1.250 | |
| | Haji Chah | 12 | 1.500 | |
| | Kili Wafa | 13 | 1.625 | |
| | Shahugheri | 17 | 2.125 | |
| Kharan | Tatagar | — | 0.000 | |
| (Eastern, | Baz Pat | 2 | 0.250 | 0.125 ± |
| low density area | Shelli Pat | 1 | 0.125 | 0.0510 |

TABLE 2

APPROXIMATE ESTIMATES OF THE POPULATION OF THE HOUBARA BUSTARD IN DIFFERENT REGIONS OF CHAGAI AND KHARAN DISTRICTS, IN FEBRUARY 1984

| General Area | Approximate area* with bustard habitat (km$^2$) | Density of** Houbara (bird/km$^2$) | Estimated Population |
|---|---|---|---|
| Western Chagai | 10,000 | 0.0208 | 208 |
| Central Chagai | 3,500 | 0.3438 | 1,193 |
| Eastern Chagai | 1,700 | 0.4375 | 748 |
| Kharan (Western, high density area) | 12,.750 | 1.1125 | 12,515 |
| Total | 27,950 | | 14,664 |

[*] Excluding the areas under steep hills and about 1/4th of the area rendered unfavourable by human settlements in the area.

[**] From Table 1.

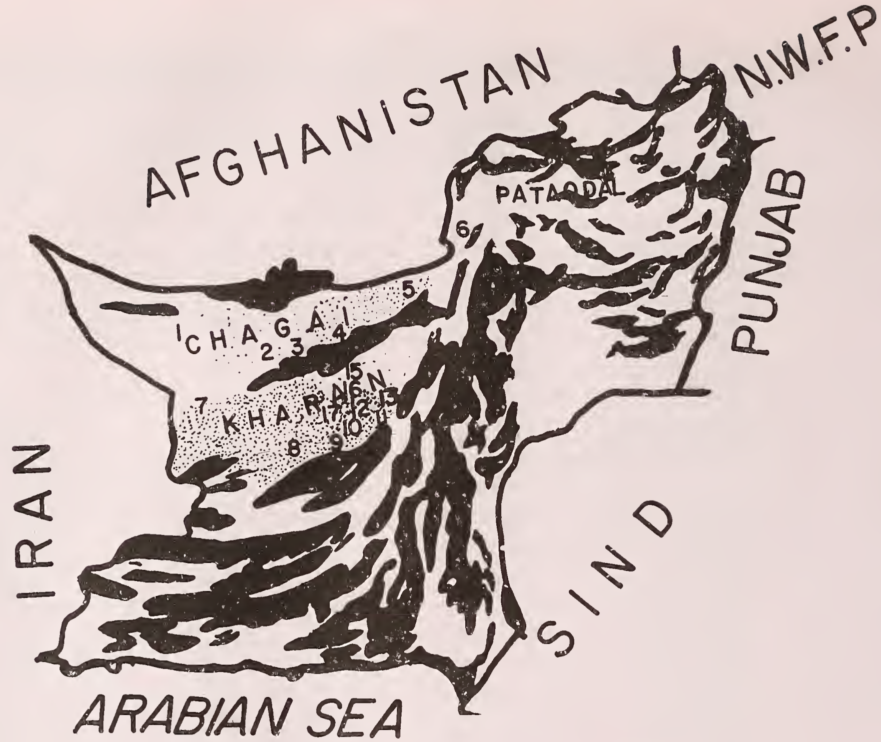

Fig. 1. Line sketch of Baluchistan,
showing relative population density of the Houbara and approximate location of the areas mentioned in text.
1. Nokkundi 2. Yakmuch 3. Dalbandin 4. Padag 5. Nushki 6. Panjpai 7. Mashkhel 8. Plantak 9. Washuk 10. Shamshi 11. Tagab 12. Shelli Pat 13. Baz Pat 14. Kharan 15. Tatagar 16. Jalwar 17. Garruk.

the density of the Houbara was highest in western Kharan (1.1125 birds per km$^2$) followed by eastern Chagai (0.4375), central Chagai (0.3438) and eastern Kharan (0.125). Western Chagai had a very scanty population with overall density of just 0.0208 birds per km$^2$. The preliminary results allow us to suggest a tentative distribution map of the Houbara population in these two districts (Fig. 1). The population density of the wintering Houbara in central and eastern Chagai and western Kharan, during February 1984, is thus higher than the one estimated for the Punjab (Pakistan, 0.12 birds per km$^2$ in Cholistan; Goriup 1980) and the Sind (Pakistan, 0.333 birds per km$^2$; Surahio 1981, 1982). It would also suggest that the favourable tracts of Chagai and Kharan harbour a very rich population of this bustard species (overall density of 0.5580 birds per km$^2$). Thus this is the richest population of the Houbara Bustard throughout the world (Goriup 1980,1981).

The population of the bird seems to be the highest in Kharan and the region suggests an overall density of 0.8846 birds per km$^2$ (pooled for the total area of Kharan). A band of very favourable bustard tract extends over an extensive area running from Garruk, in the southeastern Kharan, through Shamsi Lorha, Ahmad Shah, Zangi and Sabzab to Siahkoh in northwestern Kharan (Mashkhel), and Washuk and Planktak in southwestern Kharan. All these areas have a very high bustard density, which is estimated to be around 1.1125 birds per km$^2$. Certain other areas around Kharan exhibited a comparatively low density of the bird population with 0.00, 0.125 and 0.250 birds per km$^2$, in Tatagar, Shelli Pat and Baz Pat respectively. The overall density in these comparatively low bustard areas of Kharan is calculated to be 0.125 birds per km$^2$, and this low density is attributed to human disturbances in the area (Fig. 1).

Our results tend to suggest that some 15,000-20,000 birds of this bustard species were present in Chagai and Kharan districts and adjacent areas in February 1984. These estimates provide a reasonable idea regarding the total number of the birds which spend the winter in southern and south-western Baluchistan and the adjacent areas, because the return migration of this bustard towards the northern latitudes had already started. The birds of the southern and western (comparatively hotter) regions, like Punjgur, Mekran, Sibi, Kohlu, Mari and Dera Bughti had already moved into the northern areas of Kharan and Chagai. Our discussions with the local hunters in the southern parts of Kharan, i.e., Tagab Dal, indicated that whereas some 3-4 birds were seen in the two quadrats studied by us, one could easily observe 15-20 birds during a walk of some 20 km during the month of January. Further, the declining population levels in the southern areas like Washuk and Plantak might have forced the visiting Arab falconry party to move to the northern areas of Urmagai in northeastern Kharan towards the end of February. Similarly, the area around Nushki (eastern Chagai) is known to have had a very meagre population of the bird till January, but the present population density of the bird was quite high (0.4375 birds per km$^2$) in the region during this part of the year. The only other area expected to hold a population of the Houbara during this part of the year are towards Panjpai (29° 46'N, 66° 46'E), Patao Dal (30° 82'N, 68° 47'E, approx.) and Zhob, which are comparatively smaller tracts with a capacity of holding not more than 400-500 birds.

The present estimate regarding the total population of the Houbara Bustard in Baluchistan comes reasonably close to our previous density estimates regarding this population, which were mainly based upon the hunting successes of the Arab falconers in the area (Mian 1984). Further, one cannot expect the visiting hunters in the area to claim very high bag sizes in a small population. These estimates also fall close to the one suggested for a 250,000 km$^2$ tract in the Kyzyl Kum province of the U.S.S.R., which is regarded as the main breeding grounds of the bustard (one pair per 15-20 km$^2$, giving a total population of 28571 birds; Ponomareva 1979).

## ACKNOWLEDGEMENTS

Thanks are due to M/s K.M. Shams (Chief Conservator), M. Shafiq (DFO, Wildlife), Arbab Inayat Ullah (SDFO, Wildlife) and a number of workers of the Provincial Forest Department, for their kind help.

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# BIOLOGY AND BEHAVIOUR OF THE WILD GOAT AND THE URIAL AT A WATER POINT IN KIRTHAR NATIONAL PARK, PAKISTAN[1]

W. DANIEL EDGE[2], SALLY L. OLSON-EDGE[2] AND NASIR GHANI[3]

*(With two text-figures)*

The biology and behaviour of the wild goat (*Capra aegargrus*) and the urial (*Ovis orientalis* Gmelin) at a water point in Kirthar National Park were studied from 21 March to 21 May 1986. The water point was observed for a total of 416 hours during 32 days. Thirty-four wild goats and 8 urial were captured and marked for individual identification. Average group sizes of wild goats and urial were 18.8 and 3.8 respectively. Only 49% of the wild goat and 36% of the urial groups that approached water actually drank. The mean number of wild goats visiting the water point per day increased from March through May. Wild goats showed no preference for time of the day during which they visited the water point, but the majority of the urial visits occurred in the late afternoon and early evening. The behaviour of both species as they approached the water point is described. The management implications of the results are discussed. Water points that are developed in arid regions to benefit wild goats and sheep should have reservoirs which will provide sufficient water under drought conditions. The security of the 2 species should be considered when locating water developments.

## INTRODUCTION

Kirthar National Park was created in 1974 for the preservation of wild goats and the urial, but it had been a game reserve with restricted hunting since 1930 (Stockley 1936). With the exception of brief studies by Schaller (1977, 1979) and natural history notes by Roberts (1967), little is known about the ecology and biology of these two species in Pakistan.

Kirthar National Park is an arid desert environment in which water is probably a limiting resource for animal populations. The purpose of this paper is to examine aspects of biology and behaviour of wild goats and the urial around a water point in the Karchat Hills of Kirthar National Park.

## STUDY AREA

Kirthar National Park is located in the southwestern portion of Sind Province, Pakistan, and is 150 km northeast of Karachi, between latitudes 25°10'N and 26°05'N and longitudes 67°10'E and 67°55'E. The western border is formed by the Baluchistan provincial boundary and the eastern by the Surjan, Sumbak, and Hothiano Game Reserves. The mean maximum and mean minimum temperatures from March through May were 27°C and 38°C respectively. No weather station was maintained in the park, but local residents reported that there had been very little rainfall for two years. The 308,733 ha. area encompasses the Karchat Hills, of which Schaller and Laurie (1974) give a detailed description. Janko water point is located in the southern portion of the Karchat Hills. This natural permanent spring occurs in a wooded dry wash, running north to south, bounded by limestone cliffs on either side which widen at the vicinity of the water point. Water collects in a series of pools formed from natural depressions in the limestone bedrock in combination with concrete that was added to increase the capacity of the pools.

Most of the water is held in 3 main pools, each approximately 1.5 m in diameter and 20–30 cm deep when full, with an approximate capacity of 400 litres. These lie directly under the eastern cliff face, which is 6–7 m high at that point. Water flows into the upper two pools from fissures in the cliff base at approximately 10 litres per hour. Seven metres to the north of the pools is a seep area where a small amount of water collects in shallow depressions in the bedrock. One additional small pool lies 11 m north of the seep; it is about 60 cm in diameter and 10 cm deep, and holds about 30 litres when full. The east cliff wall reaches a high point of 10 m just north of this pool; this slopes gently to the east and

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provides a good overlook of the waterholes. We refer to this as the staging area. A ridge runs parallel to, and east of the wash. Seventy metres east of the staging area, the ridge is topped by a distinctive layer of rocks which we called the rimrock. A shaded area referred to as the cave is found under the east cliff where the wash makes a bend towards the west, 200 m north of the water point. Another ridge runs parallel to the first, on the west side of the wash; a permanent rock and a thatch *machan* is located near the top and is 66 m southwest of the waterholes.

## Methods

Wild goats and the urial were observed with 10 x binoculars or a 15-35 x spotting scope. Observations at the water point were made from the *machan*. Systematic surveys were conducted at weekly intervals throughout the southern third of the Karchat Hills. Goats and urial were captured with a remotely fired net-gun aimed at the upper waterhole, or with two Aldridge leg-hold snares placed around the lower waterholes. Sex and age of each captured animal was determined, and plastic ear tags, numbered and colour- coded for individual identification, were placed in each ear. The lead animal in a group was the focal animal used for timed events. Age classifications followed Schaller (1977). Differences in sample means were determined by use of T-test, and correlation analysis was used to test the relationship between group size and time required to reach the water point.

## Results

We watched the Janko water point for a total of 416 hours, over 32 days of dawn to dusk observations, between 21 March and 21 May 1986. During this period, we captured and marked 34 wild goats (26 females and 8 males), 10 in snares, and 24 with a net- gun. Eight urial (4 males and 4 females) were captured with the net-gun.

### Wild Goats

One hundred and fifty-two groups of wild goats approached the water point during our observations, but only 75 (49%) of these actually drank. The adult female-young ratio in May was 100:27. The mean size of the 152 groups was 18.8 (S.D. = 22.8) and was significantly larger ($t = 3.38$, $P$ 0.01) than the group size ($X = 10.4$, S.D. = 11.9) of wild goats observed away from the water point. The mean number of wild goats drinking from the water point increased from March through May (Fig. 1). Wild goats approached the waterhole throughout the day (Fig. 2)with no apparent preference for any time period.

Wild goats used three main routes when approaching the water point. The majority of groups (79.9%) approached the water by moving from the rimrock directly to the staging area and from there down the cliff face to the water. The second route, used 8.6% of the time, involved moving from the rimrock down to the cave in the cliff face, then along the top or bottom of the cliff to the staging area, and then to the water. This route was used primarily during midday, apparently because the cave and cliff face provided shade. The third route was used 6.7% of the time, mostly by male groups. This route began at the far end of the east cliff; the goats walked along the top of the cliff and either stopped at the cave, or continued along the top of the cliff to the staging area. Several other routes were used 4.8% of the time, with animals approaching the water from along the west cliff or down the wash.

Regardless of the route, wild goats approached the water cautiously and remained alert throughout their approach. The average time from when they were first seen until they reached the water was 58 minutes (S.D. = 43.7), and was not related to group size ($r = 0.20$, $P$ 0.1). Goats would stand or bed down at various places along each route, and often 30 minutes or more was spent at the staging area above the water. Lactating females and young were usually the first to drink. However, once 1 or 2 animals reached the water, the majority of the group would rapidly follow. Once at the water, wild goats drank quickly, rarely spending more than two minutes drinking. Based upon the number of goats that drank from a basin of known volume, adult females consumed approximately 5.5 litre of water. This represents 17% of the average weight of an adult female (n = 20). Once an animal finished drinking, it moved away from the water point at a steady pace, usually towards and over the rimrock, and out of sight to the east.

Eighteen marked goats were observed approaching the water point 117 times. Individual marked goats returned to the water point every 1.7 days. Because the number of consecutive days we

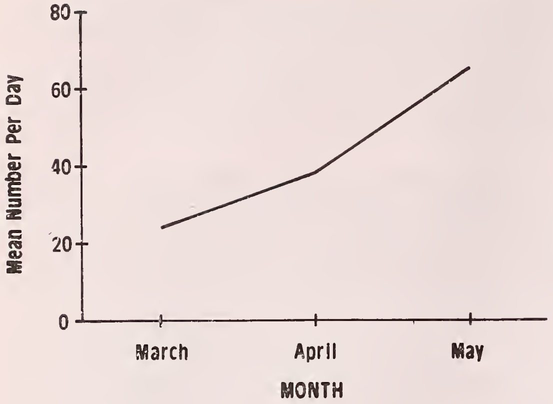

Fig. 1. Mean number of wild goats drinking water per day at Janko waterpoint, by month.

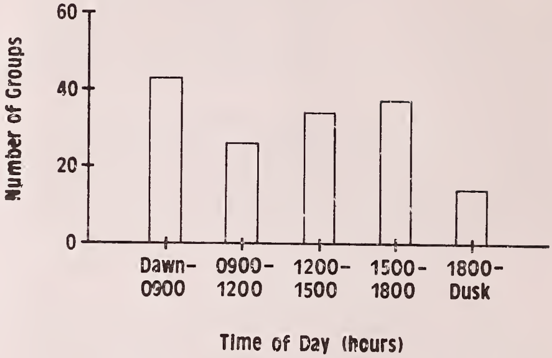

Fig. 2. Time of day of visits by wild goat groups to Janko waterpoint, March through May 1986.

watched the water point rarely exceeded 5 days, this estimate is probably biased on the low side. Every 3 days is probably a more realistic estimate.

### Urial

Twenty-eight groups of urial approached the water point during our observations, but only 36% of these drank. Average size of urial groups at the water point ($\bar{X}$ = 3.8, S.D. = 2.88) did not differ ($t$ = 0.945, $P$ 0.1) from 14 groups observed away from the water point ($\bar{X}$ = 4.7, S.D. = 2.9). In May, the adult female-young ratio was 100:53.

Urial approached the water point from several different routes, but 70% of all approaches were directly down the wash. The average time from first observation until drinking was 50 minutes (S.D = 52.6). This value is not directly comparable to the average approach time for wild goats because the route, down the wash, taken by the majority of urial, kept them out of view until they were 30 m from the water. It was our impression that urial were much more wary than the wild goats when approaching the water point. Urial approached the water primarily in the late afternoon and early evening.

### Interspecific Behaviour

Interspecific behaviour was noted on seven occasions during our observations. These resulted in physical contact twice. A class IV male goat butted a class IV male urial in the ribs, pushing him down from a 3 m cliff. The urial ran rapidly off, but apparently was not injured. The second physical contact between the two species occurred when an adult female goat threatened a young urial with a head-down display. An adult female urial immediately turned and butted heads with the goat, after which they both walked away. The other five interactions resulted in the urial being displaced by either head-down threats or stiff- legged approaches by goats. In one case, a class IV adult male urial was displaced by an adult female goat.

## DISCUSSION

The importance of water to wild goats and urial in the desert habitat of Kirthar National Park cannot be overstated. Water was especially important to wild goats during our study because the Janko water point was the only permanent water available within the herd's home range after two years of drought. The urial were probably just as dependent upon free water, but our observations do not bear this out because other sources of water were available to urial. A small water point 400 m south of the Janko water point was used by urial, but not by wild goats, apparently because of the lack of steep escape topography. The urial in this area were also reported by local game watchers to use a small stream on the plains, 5 km west of the Janko water point, but we were unable to verify that claim.

Individual wild goats visited the Janko water point every 2 to 3 days, and lactating females and young appeared to be the most dependent upon free water. Herd productivity may be directly related to the availability of water. Roberts (1967) and Schaller and Laurie (1974) both reported that natality was highest during years following a rut which occurred after abundant rainfall. Schaller (1979) also suspected that survival of young may be low during years of drought because of poor nutrition. We believe that survival of young may also be dependent upon the availability of free water. The low adult female-young ratio (100:27) observed by us was probably directly related to drought conditions. The higher female-young ratio (100:53) for urial may reflect a better adaptation to drought conditions. Population size of desert bighorn sheep in the United States is limited by the distribution of water (Welles and Welles 1961, Russo 1956, and Hansen 1965). Leslie and Douglas (1979) reported that desert bighorn ewes in the River Mountains of Nevada restricted their movements and showed a high degree of fidelity to water sources.

During drought years the demand for free water may exceed the supply; mortality would therefore be expected to increase. Based upon our rate of flow estimates for the springs at Janko water point, the average number of wild goats drinking per day, and our estimated consumption of water per animal, by May the demand for water exceeded the rate of flow. During May, the reservoir of water in the pools dropped noticeably and was severely depleted on several occasions. This condition demonstrates the need for construction of reservoirs whose capacity exceeds demands under the most severe drought conditions. Use of these sites by domestic livestock should be discouraged.

Both the urial and wild goats approach the Janko water point very cautiously. This behaviour is normal and probably reflects a relatively high potential for predation when animals are concentrated around a water point. During our observations, wild goats and urial were scared away from the water point 8 times by jackals (*Canis aureus*) and twice by domestic dogs (*Canis familiaris*). On one occasion a jackal killed a young wild goat. Thus, when constructing future water catchments for wild goats and urial, the animals' security must be considered. However, what is considered safe by one species may not be by the other. The cliffs surrounding the Janko water point, which make the site attractive for wild goats, may be a reason the water point is rarely used by urial. Desert bighorn sheep in North America prefer open space around water points to enable them to spot potential danger (Hansen 1980). The urial probably has a similar preference, but this needs to be examined further.

The interspecific encounters we observed indicate that urial almost always defer to wild goats. This behaviour, especially at water points during drought conditions, may give wild goats a competitive advantage over urial. This again emphasizes the need for water points of sufficient capacity to meet the requirements of all wildlife species.

## ACKNOWLEDGEMENTS

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# ON THE BASKING BEHAVIOUR OF THE MUGGER *CROCODYLUS PALUSTRIS* LESSON (REPTILIA : CROCODILIA) AT BHORSAINDA CROCODILE SANCTUARY, HARYANA STATE[1]

R.C. GUPTA AND P. SRI HARI[2]

*(With two text-figures & a map)*

Basking behaviour of *Crocodylus palustris* has been studied at Bhorsainda Crocodile Sanctuary in Kurukshetra District, Haryana State. Basking was observed for one complete winter season (1985-86) at weekly intervals. The animals were observed continuously for 12 hours. Maximum basking takes place for 8 hours in February and 7 hours in November. Minimum basking takes place for 1 hour in April and 2 hours in October. Basking patterns are of three kinds: (1) Individual basking which takes place in October and November, (ii) Group basking which takes place in December and January, and (iii) Mating pair basking which takes place in February and March.

## INTRODUCTION

Dharmakumarsinhji (1947), Singh (1979, 1983), Whitaker and Whitaker (1976) and Yadav (1979) studied various aspects of the behaviour of the mugger (*Crocodylus palustris*).

However, there appear to be no studies on the basking behaviour of these animals. The present paper deals with the important aspects of basking behaviour of *Crocodylus palustris* at Bhorsainda Crocodile Sanctuary in Kurukshetra District, Haryana State.

Basking is crucial for crocodiles during cold months as it enables them to warm up, thus bypassing the dormant stage so common in reptiles during winter.

**Description of study site:** ( Fig. 1, Map 1).

The crocodile Sanctuary is situated on Kurukshetra-Pehowa Road near Bhorsainda village at a distance of 13 km west of Kurukshetra University Campus, Kurukshetra (29°45'N, 76°44'E).

The total area of the sanctuary is 8 acres. The main topographical features are: (i) circular water body, (ii) mound of settled sand. The water body is approximately 1.25 m deep in the center. It is artificially fed by a feeder originating from Bhakra-Saraswati Canal. This water level is maintained throughout the year. The flora consists of species of *Nilumbium*, *Ipomoea*, *Pistia* and *Eichhornia* species. The submerged weeds are *Valisneria*, *Hydrilla*, *Chara* and *Potamogeton* species. The nectonic fauna comprises of fishes, mainly *Labeo* sp. and *Channa* sp. Birds like the Weaver bird (*Ploceus philippinus*) and the Cattle Egret (*Bubulcus ibis*) nest on the nearby trees.

The mound is circular in shape, 243.60 m in circumference and 5 m in height. The soil is settled and has grassy patches. The circular canal is interrupted at one place by a longitudinal stretch of earth, which provides a passage to approach the mound.

The various tunnels scattered round the mound are significant features of the sanctuary and have been dug by the crocodiles. The distribution (direction and distance from water), use and disuse of various tunnels at the Sanctuary complex is shown in Table 2.

The main seasons are winter (October to March), spring (April to May), monsoon (June to August) and autumn (September). The maximum and minimum temperatures recorded during these seasons are:

| Season | Maximum temperature | Minimum temperature |
|---|---|---|
| | °C | °C |
| Winter | 29 | 11 |
| Spring | 41 | 21 |
| Monsoon | 42 | 30 |
| Autumn | 38 | 29.5 |

**Description of basking site:**

The basking site chosen by the crocodiles of the Sanctuary is unique as it provides them the safest undisturbed site, with maximum solar radiation and

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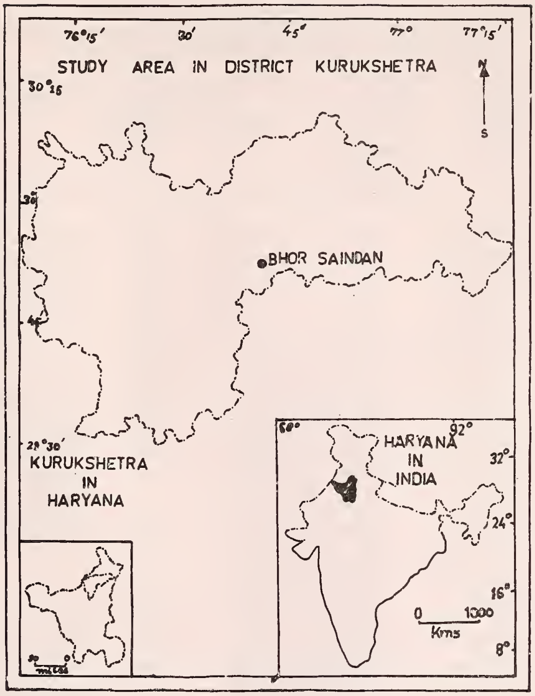
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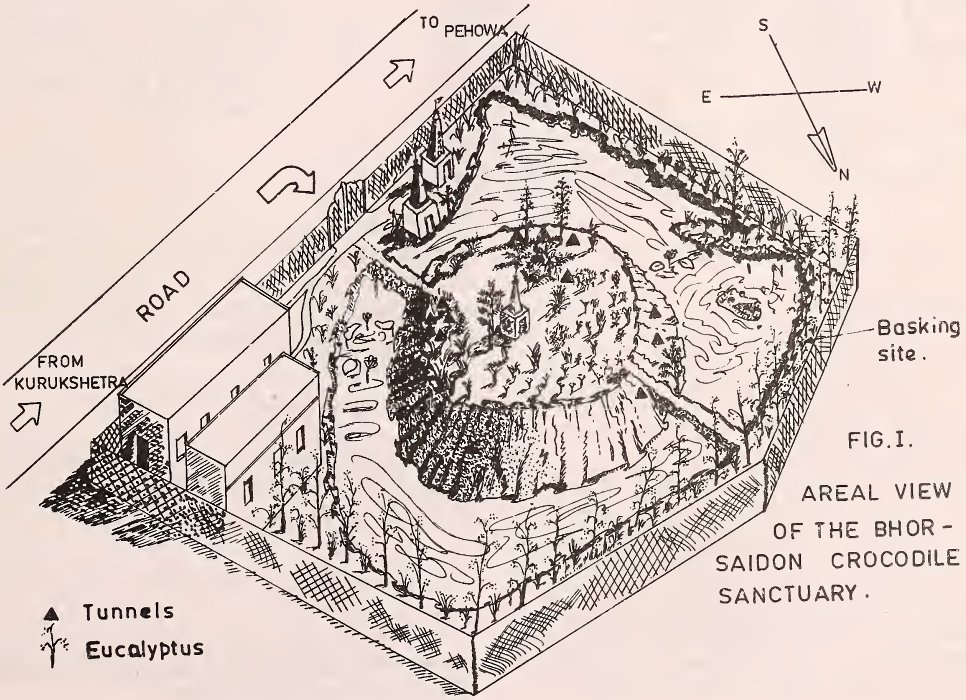
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Basking site.
▲ Tunnels
Eucalyptus

FIG. I.

AREAL VIEW OF THE BHOR-SAIDON CROCODILE SANCTUARY.

TABLE 1
TIME DEVOTED FOR BASKING BY *C. palustris* FROM 13 OCT 1985 TO 26 MAR 1986 AT WEEKLY INTERVALS
SELECTED WEATHER PARAMETERS ALSO SHOWN

| Sr. No. | Date(s) | Time of arrival on land | Time of departure into water | Time spent for basking (hours) | Temperature Maximum (°C) | Temperature Minimum (°C) | Rainfall | Humidity (%) Wet | Humidity (%) Dry |
|---|---|---|---|---|---|---|---|---|---|
| 1. | 13 Oct 85 | 1500 hrs. | 1630 hrs | 1.5 | 35 | 32 | 7th, 8th & 9th Oct, rainfall was 4 mm, 7.1 mm & 23.1 mm. | 85 | 85 |
| 2. | 20 Oct 85 | 1600 hrs. | 1700 hrs. | 1.0 | 29 | 24 | | 84 | 84 |
| 3. | 27 Oct 85 | 1200 hrs. | 1600 hrs. | 4.0 | 29 | 24 | | 84 | 86 |
| 4. | 4 Nov 85 | 1130 hrs. | 1700 hrs. | 5.5 | 27 | 25 | | 84 | 85 |
| 5. | 12 Nov 85 | 1130 hrs. | 1630 hrs. | 5.0 | 25 | 21 | | 83 | 84 |
| 6. | 18 Nov 85 | 1100 hrs. | 1800 hrs. | 7.0 | 24 | 21 | | 83 | 84 |
| 7. | 24 Nov 85 | 1100 hrs. | 1830 hrs. | 7.5 | 24 | 21 | 10th & 11th Dec, rainfall was 10.5 mm & 1.2 mm. | 82 | 84 |
| 8. | 30 Nov 85 | 1030 hrs. | 1830 hrs. | 8.0 | 22 | 18 | | 82 | 83 |
| 9. | 7 Dec.85 | 1100 hrs. | 1830 hrs. | 7.5 | 21 | 16 | | 82 | 83 |
| 10. | 13 Dec 85 | 1000 hrs. | 1700 hrs. | 7.0 | 19 | 17 | 25th & 26th Dec, rainfall was 10.5 mm & 11.1 mm. | 82 | 82 |
| 11. | 31 Dec 85 | 1130 hrs | 1700 hrs. | 5.5 | 15 | 12 | | 82 | 82 |
| 12. | 7 Jan 86 | 1100 hrs. | 1600 hrs. | 5.0 | 14 | 11 | | 82 | 83 |
| 13. | 14 Jan 86 | 1100 hrs. | 1730 hrs. | 6.5 | 17 | 13 | | 78 | 82 |
| 14. | 24 Jan 86 | 1000 hrs. | 1730 hrs. | 7.5 | 20 | 14 | | 79 | 82 |
| 15. | 1 Feb 86 | 0930 hrs | 1800 hrs. | 8.5 | 20 | 14 | 9th, 10th & 13th Feb, rainfall was 18.2 mm, 9.8 mm & 2.2 mm. | 79 | 83 |
| 16. | 4 Feb 86 | 0830 hrs. | 1700 hrs. | 8.5 | 23 | 16 | | 78 | 83 |
| 17. | 14 Feb 86 | 0900 hrs. | 1800 hrs. | 9.0 | 19 | 16 | | 78 | 83 |
| 18. | 24 Feb 86 | 1000 hrs. | 1730 hrs. | 7.0 | 21 | 15 | | 78 | 83 |
| 19. | 2 March 86 | 0800 to 1200 hrs. | 1500 to 1800 hrs. | 7.0 | 24 | 19 | 21st Feb, rainfall was 3.8 mm. | 83 | 84 |
| 20. | 23 Mar 86 | 0730 to 1000 hrs. | Discontinuous | 4.0 | 26 | 21 | 11th, 14th & 18th Mar, rainfall was 3.3 mm 0.6 mm & 13.6 mm. | 83 | 85 |
| 21 | 27 Mar 86 | Discontinuous | Discontinuous | 4.00 | 31 | 27 | | 83 | 86 |

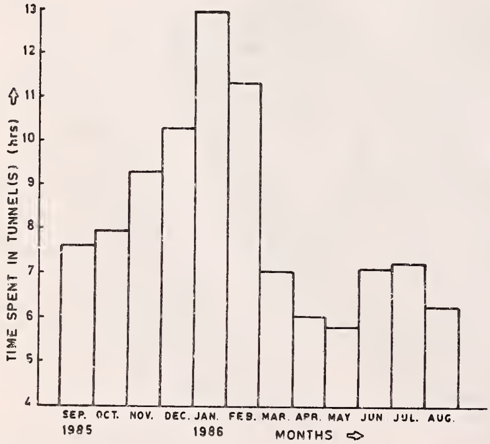

Fig. 2. Time spent in tunnels by *C. palustris* at Bhorsainda Crocodile Sanctuary (Sept. 1985–Aug. 1986).

minimum wind currents. The site is a sort of platform situated in the west of the Sanctuary, where *Eucalyptus* plantations serve as wind breaks in the cold season, thus enhancing the effect of solar radiation on the crocodiles.

## RESULTS

Details of the time spent by the animals on land for basking are given in Table 1 and Fig. 2. Details of climatic parameters are also given in Table 1.

## DISCUSSION

Basking lasts for six months, beginning in the second week of October and ending in the last week of the following March (Table 1).

TABLE 2
DETAILS OF DISTRIBUTION, DIRECTION, DIAMETER AND UTILIZATION OF TUNNELS FROM 22.9.1985 AT BHORSAINDA CROCODILE SANCTUARY

| Tunnel No. | Direction | Distance from water level | Periphery of the tunnel(s) | Abandoned months | Utilized months |
|---|---|---|---|---|---|
| 1. | South | 27.10 m | 3.80 m | Dec, Jan, Feb | Sept, Oct, Nov, March, April, May, June, July, Aug. |
| 2. | South | 27.80 m | 2.60 m | Dec, Jan, Feb. | Sept, Oct, Nov, March, Apr, May, July, Aug. |
| 3. | South | 27.80 m | 2.20 m | Dec, Jan, Feb. | Sept, Oct, Nov, March, Apr, May, June, July, Aug. |
| 4. | West | 3.50 m | 3.00 m | Sept, March, April, June, July, Aug. | Oct, Nov, Dec, Jan, Feb, May. |
| 5. | West | 1.50 m | 3.50 m | Oct, March, April, June, July. | Sept, Nov, Dec, Jan, Feb, May. |
| 6. | West | 14.50 m | 2.10 m | Sept, Nov, Feb, March, April, May, June, July, Aug. | Oct, Dec, Jan. |
| 7. | West | 4.00 m | 2.80 m | Oct, Nov, Dec, Jan, Feb, Mar, Apr, May, June. | Sept, May, June, July. |
| 8. | West | 16.40 m | 2.40 m | Oct, Nov, Dec, Jan, Feb, March, April, May, June. | Sept, July, Aug. |
| 9. | North | 16.00 m | 2.15 m | Sept, March, June, July. | Oct, Nov, Dec, Jan, Feb, April, May, Aug. |
| 10. | North | 17.50 m | 2.40 m | Oct, Nov, Dec, Jan, Feb, March, April. | Sept, May, June, July. |
| 11. | North | 23.20 m | 3.20 m | Oct, Nov, Dec, Jan, Feb, March, April, May. | Sept, Oct, Nov, April. |
| 12. | North | 23.20 m | 3.00 m | Dec, Jan, Feb, March, May, June, July, Aug. | Sept, Oct, Nov, April. |
| 13. | East | 0.40 m | 2.00 m | Oct, March, April, May, June, July, Aug. | Sept, Nov, Dec,Jan, Feb. |

The maximum time spent at the basking site was in February followed by November (Table 1; Fig. 2). The minimum time spent was in April. However, the beginning of basking seems to be of longer duration in October than in April (Fig. 2; Table 1). The time devoted to basking by crocodiles is also relatively high in January and December (Table 1).

The basking patterns observed during the investigations are of three kinds: (i) Individual basking, (ii) Group basking, and (iii) Basking during mating season.

Individual basking is prevalent during October. In this category, the animals prefer to bask alone. Another salient feature of this period (October to November) is that crocodiles bask at different times at different places.

Group basking is prevalent in December and January. The salient features of this kind of basking are that the animals prefer to bask in a single group at a time,and that basking takes place in a single stretch of time at the basking site. The animals, after arriving at the basking site,seldom leave for the water again during December and January. However, in sharp contrast to this pattern, during October and November they may first come out on land for basking, then return to the water for a short span of time and finally come again to the basking site to resume basking.

The basking pattern in February and March is similar to that found in October and November, i.e basking is interrupted. There are fourteen crocodiles in this Sanctuary. During the mating season it was found that crocodiles pair up (five pairs) at different places during the basking time. It is considered that this period was 'mating basking period'. The other four crocodiles remained unpaired, scattered at different places.

## Conclusions

Basking takes place for six months (October to March). Maximum basking takes place in February followed by November. Minimum basking takes place in April. Basking, therefore, is perhaps not directly correlated with the lowest temperatures, as it is more in February and November than in December and January. The findings suggest the possibility of existence of a most favourable spectrum of low temperatures in winter. The lowest temperatures evidently serve as inhibitors for basking. Basking is of three kinds: (i) individual basking, (ii) group basking, and (iii) mating pair basking.

## Acknowledgements

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# MATERIALS FOR FLORA OF MAHABALESWAR - 6A

P.V. BOLE AND M.R. ALMEIDA

### PLANTAGINACEAE

1. **Plantago major** Linn. Sp. Pl. 112, 1753; FBI 4:705; Birdwood, 23; Cooke, T. 2:597 (2:560); Puri & Mahajan, 130.

*P. asiatica* Linn. Sp. Pl. 163, 1753; Wight, Ill. t. 177.

Rare herb along the banks of Yenna River.

FLOWERS: September– February.

LOCAL NAME: Bartang.

Besides the species mentioned above, Lisboa (p.220) has reported *P. minus* as being cultivated at Mahabaleshwar. This may be *P. ovata* Forsk. (Isabgol), which is sometimes grown in Maharashtra for its medicinal husks. However, we have not seen it in cultivation at Mahabaleshwar in the recent past.

### NYCTAGINACEAE

#### *Bougainvillea* Comm.

1. **Bougainvillea spectabilis** Willd. Sp. Pl. 2:348, 1799; Dalz. & Gibs. suppl. 72; Cooke, T. 2:483(2:567).

Occasionally cultivated in gardens as an ornamental plant.

FLOWERS : April– May.

LOCAL NAME : Bogan Vel.

### AMARANTHACEAE

1. Leaves all opposite. .................... 2
    2. Anthers 1-celled .................... *Alternanthera*
    2. Anthers 2-celled .................... *Achyranthes*
1. Leaves not all opposite .................... 3
    3. Stamens with interposed staminodes .................... *Aerva*
    3. Staminodes absent .................... 4
        4. Ovary 1-ovulate .................... *Amaranthus*
        4. Ovary 2-many ovulate .................... *Celosia*

#### *Achyranthes* Linn.

1. **Achyranthes aspera** Linn. var. **porphyrostachya** Hook.f., in Fl. Brit. India 4:730, 1885; Birdwood, 23; Puri & Mahajan, 130; Santapau, 224.

*A. aspera* Cooke, T. in Bombay Gazet. 19:651, 1885 & Fl. Bombay Pres. 2:495 (2:580). (Pro parte).

*A. porphyrostachya* Wall. ex Moq., in DC. Prodr. 13 (2):316, 1849.

Common in partially shady places, along hedges and along forest paths.

FLOWERS, FRUITS: October— December.

LOCAL NAMES: Aghada, Serrata, Sarata.

#### *Aerva* Forsk. (nom. cons.)

1. Climbing undershrubs without terminal spikes .................... *Al. sanguinolenta*
1. Erect or diffuse herbs with terminal spikes .................... *A. lanata*

1. **Aerva lanata** (Linn.) Juss., in Mus. Par. 2:131, 1803; Graham 168; Dalz. & Gibs. 217; FBI 4:728; Lisboa, 221.

*Achyranthes lanata* Linn., Sp. Pl. 204, 1753

*A. floribunda* Wight, Icon. t. 1776 bis, f.A, 1852.

This species is reported here on authority of Lisboa. We have not seen it at Mahabaleshwar; neither have we seen any reliable herbarium specimen.

2. **Aerva sanguinolenta** (Linn.) Blume, Bijdr. 547, 1825; Santapau, 223.

*Achyranthes sanguinolenta* Linn., Sp. Pl. ed. 2, 294, 1762.

*A. scandens* Roxb. Fl. Ind. 1:676. 1832.

*Aerva scandens* Wall Ex Moq., in DC. Prodr. 13(2):302, 1849; Dalz. & Gibs. 217; Wight, Icon. t. 724 (pro parte); FBI 4:727; Cooke, T. 2: 493(2:577).

Common herb on hill-slopes and on roadsides along Fitzgerald Ghat.

FLOWERS : December – January.

#### *Alternanthera* Forsk.

1. **Alternanthera sessilis** (Linn.) R. Br. prodr. 417, 1810; Graham, 168; Dalz. & Gibs. 220; Wight, Icon. t. 727; FBI 4:731; Birdwood, 23; Santapau, 225.

*A. triandra* Lamk. Encycl. 1:95. 1783; Cooke, T. 2:499(3:584)

*Gomphrena sessilis* Linn. Sp. Pl. 225, 1753.

Common and gregarious along the moist grounds along the margins of the ponds and ditches at Chinaman's falls, Lodwick Point and near the bus-stand.

FLOWERS : Throughout the year.

LOCAL NAME : Kanchri, Jaljambha.

### *Amaranthus* Linn.

1. **Amaranthus tricolor** Linn. Sp. Pl. 989, 1753; Merrill, Enum. 2:14, 1923; Baker, 77,t. 2, 1949; Santapau, 222.

*A. gangeticus* Linn. Syst. ed 10, 1268, 1759; FBI 4:719; Cooke, T. 2:489 (2:574).

*A. oleraceus* Willd. Sp. Pl. 4:386, 1805 (non Linn. 1753); Graham, 169; Wight, Icon. t. 715, 1844-5.

*A. blitum* var. *oleraceus* Hook.f., in Fl. Brit. Ind. 4:721, 1885; Puri & Mahajan, 131.

Occasional in wastelands along roadsides and in cultivated fields.

FLOWERS & FRUITS : December – March.

### *Celosia* Linn.

1. **Celosia argentea** Linn. Sp. Pl. 205, 1753; Graham, 167; Dalz. & Gibs. 215; Wight, Icon. t. 1767, 1852; FBI 4:714; Cooke, T. 651 & 2: 485(2:570); Birdwood, 23; Puri & Mahajan, 130.

Common in wastelands and along roadsides.

FLOWERS & FRUITS: October–- November.

LOCAL NAME : Kurdu.

## CHENOPODIACEAE

1. Flowers all similar, usually hermophrodite, without bracts and bracteoles............ *Chenopodium*
2. Flowers dimorphic; female flowers with persistent, enlarged bracteoles............ *Atriplex*

### *Chenopodium* Linn.

1. Stigmas 2............ *C. album*
1. Stigmas 5............ *C. ambrosioides*

1. **Chenopodium album** Linn. Sp. Pl. 219, 1753; FBI 5:3; Cooke, T. 2:501(2;586); Ulrich. in Planzenfam. ed. 2, 16c:487,t. 1- 2; Santapau, 226.

*C. viride* Linn. Sp. Pl. 219, 1753; Graham, 171.

Rare weed in wastelands.

FLOWERS: April.

LOCAL NAME: Chakvat.

2. **Chenopodium ambrosioides** Linn. Sp. Pl. 219, 1753; Dalz. & Gibs. Suppl. 73; Wight, Icon. t. 1786, 1852; FBI 5:4; Birdwood, 23; Cooke, T. 2:502(2:587).

*Atriplex ambrosioides* Lisboa, As. Soc. (Bombay) 15:220, 1883.

Fairly common and abundant weed in cultivated fields, in gardens and in wastelands. A native of tropical America, it was introduced in India as an ornamental aromatic herb.

FLOWERS : December19 – June.

### *Atriplex* Linn.

1. **Atriplex hotensis** Linn. Sp. Pl. 1053, 1753; Dalz. & Gibs suppl. 73; FBI 5:6; Cooke, T. 2:503(2:588).

*A. heterantha* Wight, Icon.t.1787, 1852.

Rare annual herb. Known from a single collection from Chinaman's falls.

FLOWERS: April.

## POLYGONACEAE

1. Stem green, with flattened phylloclades............ *Homalocladium*
1. Stems not flattened, cylindrical............ 2
   2. Stigma capitellate............ *Polygonum*
   2. Stigma fimbridate............ *Rumex*

### *Homalocladium* (F.V. Muell.) Bailey

1. **Homalocladium platycladum** (Muell.) Bailey, Man. Cult. Pl. 351, 1947.

*Muehlenbeckea platyclados* (Muell.) Meissn., in Bot. Zeit. 23:313, 1865; Cooke, T. 2:519(3:11).

*Coccoloba platyclada* F. V. Muell., in Bot. Mag. 19:t. 5382, 1863.

Rare in cultivation in gardens.

FLOWERS : Throughout the year.

COMMON NAME : Centipede Plant.

### *Polygonum* Linn.

1. Inflorescence axillary; flowers solitary or in small clusters............ *P. plebeium*
1. Inflorescence terminal, racemose or spicate or capitate............ 2
   2. Inflorescence of branched spikes or of spike-like racemes............ 3
      3. Racemes stout, compact............ 4
         4. Nutlets orbicular or biconvex............ *P. glabrum*
         4. Nutlets trigonous............ *P. barbatulum* var. *gracile*
      3. Racemes slender, lax............ *P. mite*
   2. Inflorescence of compressed spikes, capitate............ 5
      5. Heads in the axils of involucral leaves............ *P. alatum*
      5. Heads not in the axils of involucral leaves............ 6
      6. climbing unarmed undershrub............ *P. chinense*
      6. Erect herbs, with prickles on the angles of stem............ *P. strigosum* var. *angustissima*

1. **Polygonum alatum** Buch.-Ham., in Don, Prodr. Fl. Nepal. 72, 1825; FBI 5:41; Birdwood, 23; Cooke,

T. 2:516(3:8); Puri & Mahajan, 131.

*P. pactatum* Buch–Ham. l.c. 1825 (non Elliort, nec Raffin, 1836).

*P. nepalense* Meissn., Monogr. 84, 1826; Steward, in Contr. Gray Herb. 88:74, 1930; Wight, Icon. t. 1804; Cooke, T. 651, 1885; Santapau, 401, 1962 & 305, 1963.

Common and gregarious annual herb in moist places.

FLOWERS : August– February.

2. **Polygonum barbatulum** Linn. var. **gracile** (Danser) Steward, in Contrib. Gray Herb. 88:55, 1930; Santapau, 227.

*P. serrulatum* auct. (non Lagasca, 1816); Hook.f. in Fl. Brit. Ind. 5:38, 1886; Cooke, T. 2:515(3:7); Puri & Mahajan, 131.

*P. rivulare* Graham, Cat. Bombay Pl. 172, 1839 (non Koenig. 1806); Dalz. & Gibs. 214; Cooke, T. 651; Lisboa, 221.

*P. barbatum* Woodrow, in Journ. Bombay Nat. Hist. Soc. 12:365, 1899 (non Linn. 1753); Puri & Mahajan, 131.

*P. flaccidum* Roxb., Fl. Ind. 2:291, 1832.

*P. barbatum* Linn. var. *gracile* Danser, Polygon. Neinderland. Ostond. 146, f. 2. 1927.

A rare herb along watercourses near Chinaman's falls.

FLOWERS: May.

LOCAL NAME: Dhakta Sheral.

3. **Polygonum chinense** Linn., Sp. Pl. 863, 1753; Graham, 172; Dalz. & Gibs. 214; Cooke, T. 651, 1885; Lisboa, 221; Birdwood, 23; Puri & Mahajan, 131; Santapau, 401, 1962 & 305, 1963; Steward, in Contr. Gray Herb. 88:71, 1930.

*P. chinense* Linn. var. *ovalifolia* Meissn., in Wall. Pl. As. Rar. 3:60, 1832; FBI 5:45; Cooke, T. 2:517(3:8).

Fairly common and abdundant among hedges and along roadsides.

FLOWERS: March – December.

LOCAL NAMES: Narali, Rarull.

4. **Polygonum glabrum** Willd., Sp. Pl. 2:447, 1799; Graham,172; Dalz. & Gibs. 214; FBI 5:34; Wight, Icon. t. 1799, 1852; Birdwood, 23; Cooke, T. 651, 1885 & 2:514 (3:5); Lisboa, 221; Puri & Mahajan, 131; Steward, 43.

Common and abundant perennial herb along watercourses, sometimes forming large clumps.

FLOWERS: Throughout the year.

LOCAL NAMES: Sheral, Rakta-roda.

5. **Polygonum mite** Schrank, Fl. Baier. 1:668, 1789; Cooke, T. 2:516(3:7); Puri & Mahajan, 131; Clapham et al., in Fl. Brit. Isle, 697, 1952.

Very common and abdundant herb in water-logged places. Very often the whole plant is found submerged in water with only the inflorescence visible above the water. A native of British Isles. According to Dr. T. Cooke, it might have been introduced in India along with shipment of food-grains.

FLOWERS: November – January.

6. **Polygonum plebeium** R. Br. Prodr. 420, 1810; FBI 5:27; Cooke, T. 2:512(3:4): Steward, 24.

*P. plebeium* R. Br. var. *indica* Hook.f., in Fl. Brit. India 5: 28, 1886; Cooke, T. 2:512(3:5); Puri & Mahajan, 131.

*P. indicum* Heyne, in Roth. Nov. Pl. Sp. 208, 1821; Wight, Icon. t. 1808, 1852.

*P. elegans* Dalz. & Gibs. Bombay Fl. 214, 1861 (non Roxb., 1832); Lisboa, 221; Cooke, T. 651, 1885.

*P. plebeium* var. *elegans* Birdwood, in Journ. Bombay Nat. Hist. Soc. : 23, 1897.

*P. plebeium* var. *brevifolia* Hook. f. in Fl. Brit. India 5:28, 1886; Cooke, T. 2:514(3:5).

Very variable species. Common and abundant diffuse herb in drying rice-fields and in wastelands along watercourses. Rev. Fr. H. Santapau, in Khandala Flora (ed. 3, p. 226) observes, "The varieties and formas of this species vary depending on the amount of moisture and shade". He keeps all varieties and formas under *P. plebeium* R. Br. without further classification. However, two varieties of our Mahabaleshwar specimens could be distinguished:

1. Stipules and leaves covering internodes............... var. *brevifolia*
1. Stipules and leaves not covering internodes............. var. *indica*

FLOWERS: November– June.

7. **Polygonum strigosum** R. Br. prodr. 420, 1810. var. **angustissima** (Hook.f.) comb. nov. *P. pedunculare* Wall. var. *angustissima* Hook.f.Fl. Brit. Ind. 5:48, 1886; Birdwood, 23; Cooke, t. 2:517(3:9); Puri & Mahajan, 131.

Rare herb, occasionally found at Lingmala falls and near Bhilar.

FLOWERS: November.

Steward (in Contrib. Gray Herb. 88:91, 1930) has reduced *P. pedunculare* Wall. ex Meissn (in

Wall. Pl. As. Rar. 3:58, 1832) to the varietal rank under *P. strigosum* R. Br. Therefore, *P. pedunculare* Wall. var. *angustissima* Hook.f. has to be treated as another variety of that species.

### *Rumex* Linn.

1. **Rumex dentatus** Linn. Mant. 2:226, 1771; FBI 5:59; V.D. Vartak, in Journ. Univ. Poona, 10:11, 1959.

This species has been reported to have been seen in cultivation at Mahabaleshwar, by V.D. Vartak.

## PODOSTEMONACEAE

### *Griffithella* (Tul.) Warm.

1. **Griffithella hookeriana** (Tul.) Warming, Fam. Podost. Aflandal. 6:13, 1901; Cooke, T. 2:521 (3:13).

*Mniopsis hookeriana* Tul., in Ann. Sci. Nat. Ser. 3, 11:105, 1849; Wight, Icon. t. 1918, f. 4, 1852; Dalz. & Gibs. 245.

*Podostemon hookerianus* Wedd., in DC. Prodr. 17:74, 1873; FBI 5:65.

Common, flat, thalloid water plant attached to rocks in running waters. This species has been collected from Koina River, below Mahabaleshwar. We have not seen it on the plateau.

FLOWERS: October– December.

LOCAL NAME: Khadak–Phul.

## ARISTOLOCHIACEAE

1. Petioles less than 1.5 cm long........................................ *A. indica*
1. Petioles more than 4 cm long........................................ *A. tagala*

### *Aristolochia* Linn.

1. **Aristolochia indica** Linn. Sp. Pl. 960, 1753; Graham, 178; Dalz. & Gibs. 224; FBI 5:75; Cooke, T. 2:254 (3:16).

Rare species at Mahabaleshwar. Only known from a single collection.

FLOWERS: November.

LOCAL NAMES: Sapsund, Sampsun.

2. **Aristolochia tagala** Cham., in Linnaea 7:207, 1832; Cooke, T. 2:255 (3:17).

*A. roxburghiana* Klotzch, in Monastb.-Berl. Akad. 696, 1859; FBI 5:75.

*A. acuminata* Roxb., Fl. Ind. 3: 489, 1832 (non Lamk., 1791; Graham, 178; Dalz. & gibs. 224; Wight, Icon. t. 771, 1844-5.

Dalzell & Gibson have reported this species from Par-Ghat, leading to Mahabaleshwar. We have not seen this on the plateau.

FLOWERS: October– November.

## PIPERACEAE

### *Piper* Linn.

1. Leaves hairy beneath, membranaceous.................... *P. hookeri*
1. Leaves glabrous on both surfaces, texture thick, leathery.................................................. 2
    2. Leaves rounded at the base; ripe fruits red............ *P. nigrum*
    2. Leaves acute at the base; ripe fruits yellow.................................. *P. trichostachyon*

1. **Piper hookeri** Miq., in Hook. Lond. Journ. Bot. 4:437, 1845; FBI 5:88; Dalz. & Gibs. 315; Cooke, T. 651, 1885; Birdwood, 23; Cooke, T. 2:527 (3:19); Puri & Mahajan, 131; Santapau, 399, 1962 & 305, 1963.

Common and abundant clinging climber in forest areas.

FLOWERS: April– September.

LOCAL NAME: Ran Mirvel.

2. **Piper nigrum** Linn., Sp. Pl. 28, 1753; graham, 198; Dalz. & Gibs. suppl. 84; FBI 5:90; Cooke, T. 2:527(3:19); Santapau 229.

*P. triocum* auct. (non Roxb., 1820) Graham, Cat. Bombay Pl. 199, 1839; Wight, Icon. t. 1935, 1852 (non Lamk. 1791); Birdwood, 223.

Rare climber in forest areas. Rarely cultivated in gardens for fruits.

FLOWERS: July– September.

LOCAL NAME: Kala Miri, Mirvel

3. **Piper trichostachyon** (Miq.) C. DC. in DC. Prodr. 16(1):242, 1869; FBI 5:80; Cooke, T. 2:526 (3:19).

*Muldera trichostachyon* Miq., in Hook. London Journ. Bot. 5:556, 1846; Wight, Icon. t. 1944, 1852.

Common climber in forest areas.

FLOWERS: Throughout the year.

LOCAL NAME: Ran Mirvel, Kankol.

## PEPEROMIACEAE

### *Piperomia* Ruiz & Pav.

1. Plants succulent, terrestrial herbs.......................... *P. pellucida*
1. Plants non-succulent, epiphytic herbs.............. *P. portulacoides*

1. **Peperomia pellucida** (Linn.) H.B.K., Nov. Gen.

Sp. 1:64, 1815; Cooke, T. 2:529(3:21); Santapau, 229.

*Piper pellucidum* Linn. Sp. Pl. 30, 1753.

Common weed in wastelands near human inhabitation and in cultivated fields. It is a native of S. America.

FLOWERS: August – October.

2. **Peperomia portulacoides** (Lamk.) A. Dietr., Sp. Pl. 1:172, 1831 (non Miq., 1846); Birdwood, 23.

*Piper portulacoides* Lamk., Tab. 1:82, 1791.

*Peperomia wiqhtiana* Miq., in Hook. Lond. Journ. Bot. 5:548, 1846; FBI 5:98; Cooke, T. 2:529 (3:21); Santapau, 229.

Small epiphytic herb rarely found in deeply shaded forests.

FLOWERS: May— October.

### LAURACEAE

1. Flowers hermaphrodite or polygamous.......... 2
  2. Anthers 2–celled.......... *Beilschmiedia*
  2. Anthers 4–celled.......... 3
    3. Perianth in fruits with persistent tube and usually with deciduous segments..... *Cinnamomum*
    3. Perianth in fruit with persistent reflexed segments.......... *Machilus*
1. Flowers dioecious.......... 4
  4. Flowers clustered in densely imbricating bracts (not whorled).......... *Actinodaphne*
  4. Flowers umbellate; the heads supported by 4–6 whorled bracts.......... 5
    5. Leaves penninerved.......... *Litsea*
    5. Leaves 3-nerved from base.......... *Neolitsea*

### *Actinodaphne* Nees

1. **Actinodaphne angustifolia** Nees, in Wall. Pl. As Rar. 3:31, 1832; Wight, Icon. t. 1841, 1852; Puri & Mahajan, 131; Santapau, 399, 1962.

*A. hookeri* Meissn., in DC. Prodr. 15(1):218, 1864 (excl. var. *longifolia* and including vars. *dassypoda* and *glabrata*); FBI 5:149;Cooke, T. 2:537 (3:31); Birdwood, 24.

*A. lanceolata* Dalz. & Gibs. Fl. Bombay 312, 1861; Lisboa, 221.

*Tetranthera lanceafolia* Graham, Cat. Bombay Pl. 174; 1839 (non Roxb.)., *Litsea fuscata* Lee Bombay Gazett. 19:645, 1885 (non Thwaites, Birdwood, 24; Cooke, T. 648, 1885.

One of the commonest trees on the plateau.

FlOWERS: December–January

FRUITS : January– May.

LOCAL NAME: Pisa.

### *Beilschmiedia* Nees

1. **Beilschmiedia Roxburghiana** Nees, in Wall. Pl. As. Rar. 2: 69, 1832; FBI 5:121; Dalz. & Gibs. 222.

*B. roxburghiana* var. *dalzellii* Haines, Bot. Bihar & Orissa 798, 1924.

*B. faqifolia* var. *dalzellii* Meissn., in DC. Prodr. 15(1): 64, 1864; FBI 5:122; Cooke, T. 2:534 (3:27).

*B. dalzellii* (Meissn.) Kosterm. in Reinwardtia 6:282, 1962.

Rare tree at Mahabaleshwar. Only known from a single collection.

FLOWERS: February – March.

LOCAL NAME: Kajuri.

Rev. Fr. H. Santapau, accepts the name *B. dalzellii* (Meissn.) Kosterman for this species in Fl. Khandala, ed. 3, 230, 1967. Later (in Dist. Flower Pl. India, 22, 1973), he calls plants from the Western Ghats as *B. roxburghiana* Nees.

### *Cinnamomum* Blume

1. **Cinnamomum verum** Presl. Priroz. Rostl. 2:36, t. 7, 1825; Kosterman, in K.M. Manilal, Bot. Hist. Hort. Malabar, 163, 1980.

*C. zeylanicum* Blume, Bijdr. 568, 1825; FBI 5:131; Wight, Icon. tt. 123, 134, 1844-5; Cooke, 2:525 (3:28).

*C. aromaticum* Graham, Cat. Bomb. Pl. 173, 1839 (non Linn., 1753).

*C. iners* Graham, l.c. 173 (non Blume, 1826, nec Wight, 1839).

Few trees are planted at Bhilar in a private garden. Probably introduced from elsewhere.

2. **Cinnamomum camphora** T. Nees, & Eberm. Hndb. Hed.-Pharm. Bot. 2:430, 1829.

Rarely cutlivated in gardens.

LOCAL NAME: Kapoor.

### *Litsea* Lamk. (nom. cons.)

1. Stamens 18-20.......... *l. deccanensis*
1. Stamens 12.......... 2
  2. Filaments glabrous; leaves glaucous beneath.......... *L. vertakii*
  2. Filaments hairy; leaves rusty-tomentose beneath.......... *L. floribunda*

1. **Litsea deccanensis** Gamble, Fl. Madras, 1235, 1925; Santapau, 232.

*L. tomentosa* Heyne ex Meissn., in DC. Prodr. 15(1): 177, 1862 (non Blume, 1825); Birdwood, 24; Cooke, T. 2: 539(3:32); Puri & Mahajan, 131.

*Tetranthera apetala* Graham, Cat. 174, 1839; Dalz. & Gibs. 222 (non Roxb., 1832).

*T. tomentosa* Roxb., ex Wight, Icon. t. 1834, 1852.

*L. tomentosa* var. *glabrescens* Cooke, T. Bombay Gazett. 19:648, 1885.

This species has been reported from Rotunda Ghat by Birdwood and T. Cooke. Talbot reports it from Mahabaleshwar plateau. We have not seen the plant on the plateau, nor have we seen any reliable herbarium specimen.

FLOWERS: October– January.

2. **Litsea floribunda** (Blume) Gamble, Fl. Madras, 1234, 1925;) K.N. Gandhi, in fl. Hassan Dist. 48, 1966.

*Calycodaphne floribunda* Blume, Mus. Bot. 1:387, 1857.

*L. wightiana* Hook. f., in Gen. Pl. 3:162, 1880; FBI 5: 177 (p.p.); Birdwood, 24; Cooke, T. 2:540 (3:33); Puri & Mahajan, 131 (non *C. wightiana* Nees, 1829).

*Calycodaphne wightiana* auct. (non Nees, 1829); Dalz. & Gibs. 222; Wight, Icon. t. 1883, 1852.

*Tetranthera wightiana* Wall. ex Bedd. Fl. Sylvat. t. 293, 1873 (non *C. wightiana* Nees, 1829).

This species has been reported by Birdwood on authority of Simonds, from Bombay Point. Plants labelled as this species in Blatter Herbarium have all turned out to be *L. stocksii* Hook.f.

3. **Litsea vartakii** Almeida nom. nov.

*Litsea stocksii* Hook. f., in Fl. Brit. India 5:176, 1886 (nom. illeg.); Birdwood 24; Cooke, T. 2:539(3:33); Puri & Mahajan, 131.

*Actinodaphne lanceolata* auct. (non Dalz. & Gibs., 1861); Nairne, Pl. West. India, 279, 1894 (As a synonym).

Very common tree all over Mahabaleshwar. Leaves turn reddish on drying.

FLOWERS: October– December.

In the original protologue of this species, J. D. Hooker has cited *Tetranthera lanceaefolia* Graham as one of the synonyms of the new species which is now synonymised with *Actinodaphne angustifolia* Nees. Therefore *L. stocksii* Hk.f. becomes an illegitimate name. The new specific name is given after Dr. V.D. Vartak for his interest in Mahabaleshwar flora.

Besides the species mentioned above, Birdwood has reported *Litsea polyantha* Juss. (Kala Pisa), from Arthur's Seat, leaves having Cinnamomum smell and *L. cookii* Fairbank, from Arthur's Seat. We have not been able to confirm the identity of these species.

### *Neolitsea* (Benth.) Merrill

1. **Neolitsea zeylanica** (Nees) Merrill, Gamble, in Fl. Madras, 1:240, 1925.

*Litsea zeylanica* Nees, Cinnamomum. Disput. 58, 1823; Dalz. & Gibs. 223; Wight, Icon. tt. 132 & 1844; FBI 5:178; Birdwood, 24; Cooke, T. 2: 541 (3:34); Puri & Mahajan, 131.

*L. foliosa* Nees, Syst. Laurin. 622, 1839.

Common tree all over Mahabaleshwar, especially near Arthur's Seat and Dhobi's falls.

FLOWERS: November– December.

LOCAL NAME: Kanvel, Chirchira.

### *Persea* Miller

1 **Persea macrantha** (Nees) Kosterman, Reinwardtia 6:193, 1962; Santapau, 231.

*Machilus macrantha* Nees, in Wall, Pl. As. Rar. 2:70, 1831; Dalz. & Gibs. 221; Wight, Icon. t. 1824, 1852; Bedd., Fl. Sylvat. t. 264, 1872; Lisboa, 221; Birdwood, 24; Cooke, T. 2:536 (3:29).

*M. glaucescens* Wight, Icon. t. 1825, 1852; Dalz. & Gibs. 221.

Rare tree occasionally seen in forest areas near culverts.

FLOWERS: January.

LOCAL NAME: Gulum.

## PROTEACEAE

### *Grevillea* R. Br.

1. **Grevillea robusta** Cunn., in R. Br. Prodr. suppl. 24, 1830; Puri & Mahajan, 131 (in Lauraceae); Santapau, 233.

Ornamental tree, occasionally cultivated in gardens.

COMMON NAME: Silver Oak

## THYMELAEACEAE

### *Gnidia* Linn.

1. **Gnidia glauca** (Fresen.) Gilg, Bot. Jahrb. Syst. 19:265, 1894, in obs., C.J. Saldanha, in Fl. Hassan

Dist. 275. 1977.

*Lasiosiphon glaucus* Fresen., Fl. 21:603, 1838.

*L. eriocephalus* Decne, in Jacq., Voy. Bot. 148, 1844; FBI 5:197; Cooke, T. 649 & 2:542(3:36) Lisboa 221; Birdwood, 24; Puri & Mahajan, 131; Santapau, 398, 1962 & 309, 1963.

*Gnidia eriocephala* Graham, Cat. Bombay Pl. 176, 1839; Wight Icon. t. 1859, 1852.

*L. speciosa* Decne l.c. 147, t. 150. 1844; Dalz. & Gibs. 221; Markham, 385, 1880.

Fairly common in open forests and along the forest borders in thick forests. The bark is used by local people for stupefying fish.

FLOWERS: November– January.

LOCAL NAME: Rametha, Rametta.

## ELAEAGNACEAE

1.**Elaeagnus conferta** Roxb., Fl. Ind. 1:440, 1832; Graham, 178; Puri & Mahajan, 132; Santapau, 399, 1962 & 294, 1963.

*E. latifolia auct.* (non Linn., 1753); Wight Icon. t. 1856, 1850; FBI 5:202; Cooke, T. 649, 1885; Birdwood, 24; Lisboa, 221 Cooke, 2:543(3:37).

*E. kolaga* Schletch., in DC. Prodr. 14:611, 1857; Dalz. & Gibs. 224; Markham, 385, 1885.

Common and abundant scandent or straggling climber all over in forest areas. Ellipsoidal, silvery berries are edible and are sold in local markets.

FLOWERS: December–February;

FRUITS: March– April.

LOCAL NAME: Amgul, Nurgi.

## LORANTHACEAE

1. Flowers bisexual; leaves well developed with prominent mid-rib............2
    2. Bracts cup-shaped, forming an involucre enclosing inflorescence............*Tolypanthes*
    2. Bracts not involucrate............3
        3. Each flower with 2-3 bracts............*Macrosolen*
        3. Each flower with a single bract............4
            4. Petals free............*Helixanthera*
            4. Petals united............5
                5. Flowers regular............*Dendrophthoe*
                5. Flowers irregular............6
                    6. Leaves opposite............*Loranthus*
                    6. Leaves alternate............*Taxillus*
1. Flowers unisexual; leaves absent, (when present without a mid-rib)............*Viscum*

### *Dendrophthoe* Martius

1. **Dendrophthoe falcata** (Linn.f.) Etting. in Denkschr. Akad. Wissen, Math.-Natural. Cl. 32:52-3, 58, t. 13, f. 14, 1872; Merrill, in Arn. Arbor. 8:53, 1934; Santapau, 234.

*Loranthus falcatus* Linn. f. suppl. 211, 1781.

*L. longiflorus* Desr. in Lamk. Encycl. 3:598, 1789; Graham, 86; Dalz. & Gibs. 110; Wight, Icon. t. 302, 1840; FBI 5:214; Cooke, T. 2:548 (3:42); Lisboa, 222.

*L. amplexifolia* DC. Prodr. 4:305, 1830; Graham, 86.

*L. longiflorus* var. amplexifolia Thwaites, Enum. 134, 1859; FBI 5:215.

Quite frequent parasite on Syzyqium cumini Skeel (Jambul Tree).

FLOWERS: July– January.

LOCAL NAME: bandgul. Banda.

2. **Dendrophthoe trigona** (Wt. & Arn.) Danser ex Santapau, in Rec. Bot. Surv. India 16(1): 263, 1953; Santapau, 299, 1963. Loranthus trigonus Wight & Arn., Prodr. 386, 1834; FBI 5: 219; Cooke, T. 2:249(3:43).

Macrosolen trigonus Van Tiegh. Bull. Soc. Bot. France 42:442, 1895.

Rare parasite on Xantolis tomentosa Rafin. along Fitzgerald Ghat.

FLOWERS: January– February;

FRUITS: April.

Helicanthes Dans.

1. **Helicanthes elastica** (Desr.) Danser, in Verhand. K. Akad Western. Amsterd. Sect 2, 29(6):55, 1933; Santapau, 299, 1963.

Loranthus elasticus Desr., in Lamk. Encycl. 3:599, 1789; Graham, 86; Dalz. & Gibs. 109; FBI 5:216; Wight, Icon. t. 343; Cooke, T. 649 & 2:547 (3:41); Birdwood, 24; Puri & Mahajan, 132.

Very common parasite on Flacourtia indica Merrill and Syzyqium cumini Skeels.

FLOWERS: October– December.

Helixanthera Lour.

1. Flowers more than 2 cm. long............*H. obtusata*
1. Flowers less than 1 cm long............*H. wallichiana*

1. **Helixanthera obtusa** (Schult.) Danser, in Bull. Jard. Bot. Buitens. Ser. 3, 10:317, 1929; Santapau, 300, 1963. Loranthus obtusatus Schult., Syst. 7(2): 1650, 1830; Graham, 86; Dalz. & Gibs. 109. 109; Lee, 645; FBI 5:205; Cooke, T. 649 & 2:546 (3:39); Lisboa, 222; Birdwood, 24.

Common parasite on *Memecylon umbellatum* Burm., *Flacourtia indica* Merrill and *Syzygium cumini* Skeels.

FLOWERS: May– June.

2. **Elixanthera wallichiana**(Schultes) Danser, Bull. Jard. Bot. Buitenzorg Ser. 3, 10:317, 1929; T.P. Ramamoorthy, in Fl. Hassan Dist. 307. 1976.

*Loranthus wallichiana* Schultes Syst. 7:100, 1820; Wight, Icon. t. 143, 1839; FBI 5:204; Cooke, T. 545(3:40).

*Phoenicantherum wallichiana* Schultes Syst. 7:100, 1820; Wight, Icon.t. 143, 1839; FBI 5:204; Cooke, T. 545(3:40).

*Phoenicantherum wallichiana* (Schult.) Blume in Schult.f., Syst. 7:1729, 1828.

Rare parasite on *Memecylon umbellatum* Burm.f.

### *Loranthus* (nom. cons.)

1. **Loranthus philippensis** Cham. & Schultes, in Linnaea 3:204, 1828; scurrula philippensis (Cham. & Schult.) G. Don, Gen. Hist. 3:442, 1834; Santapau, 236.

*L.scurrula* Kurz., For. Fl. 2:319, 1877; FBI 5:208 (p.p); Cooke, T. 2:546(3:40) p.p.; Birdwood, 24 (non Linn., 1753).

*L. budleoides* Desr., in Lamk. Encycl. 3:600, 1792; Graham, 86; Dalz. & Gibs. 110 (p.p) (non Thwaites, 1859).

*Scurrula parasitica* Linn. Sp. Pl. 110, 1753; Wien, in Abeywick., Fl. Ceylon 1:73, 1973 (non L. parasitica Linn., 1753).

Rare species along Fitzgerald Ghat on *Bridelia squamosa* (Lamk.) gerhn. trees.

FLOWERS: December– April.

### *Macrosolen* Blume

1. Corolla less than 3 cm long.......... M. capitellatus
1. Corolla more than 3.5 cm long.......... M. parasitica

1. **Macrosolen capitellatus** (Wt. & Arn.) Danser, in Blumea 4: 36, 1936; Santapau, 300, 1963.

*Loranthus capitellatus* Wight & Arn., Prodr. 382, 1834; Wight, Icon. t. 304, 1840; Dalz. & Gibs. 109; FBI 5:221; Cooke, T. 2:550(3:44); Puri & Mahajan, 132.

Common parasite on Actinodaphne hookeri Meissn.

FLOWERS: April–June.

## BALANOPHORACEAE

1. **Balanophora elkinsii** Blatter, in Journ. Bombay nat. Hist. Soc. 33:309-10, 1929; Santapau, 289, 1963.

*B. indica* auct. (non Wall. ex Griffith., 1846); Hart, Journ. Bombay nat. Hist. Soc. 1:75, 1886; Birdwood, 25; Cooke, T. 2:557(3:52).

Common root-parasite on Syzygium cumini Skeels.

FLOWERS: October– November.

## EUPHORBIACEAE

1. Flowers aggregate-monoecious in heads resembling a single flowers.......... *Euphorbia*
1. Flowers dioecious or separate-monoecious.......... 2
    2. Cell of the ovary 2-ovuled.......... 3
        3. Petals present, small.......... 4
            4. Fruit a capsule; calyx imbricate.......... *Actephila*
            4. Fruit a drupe; calyx valvate.......... *Bridelia*
        3. Petals absent.......... 5
            5. Disc present.......... 6
                6. Disc central, orbicular or combined with calyx lobes, eglandular.......... 7
                    7. Stamens 4-many.......... *Drypetes*
                    7. Stamens 3 in a column.......... *Breynia*
                6. Disc glandular.......... 8
                    8. Fruit a berry.......... 9
                        9. Fruits of 3-6 hard cocci in a fleshy epicarp.......... *Emblica*
                        9. Fruits with 6-12 crusta-ceous seeds.......... *Kirganelia*
                    8. Fruit a dry capsule of 3 or 2-valved cocci.......... 10
                        10. Stamens 3.......... *Phyllanthus*
                        10. Stamens 5.......... *Securinega*
            5. Disc absent.......... *Glochidion*
    2. Cells of the ovary 1-ovuled.......... 11
        11. Calyx in male flowers valvate.......... 12
            12. Filaments not branched.......... 13
                13. Anthers not vermiculiform or linear.......... *Mallotus*
                13. Anthers vermiculiform or linear linear.......... *Tragia*
            12. Filaments branched.......... 14
                14. Leaves entire, penninerved .......... *Ricinus*
                14. Leaves palmatilobed, palminerved.......... *Ricinus*
        11. Calyx in male flowers imbricate.......... 15
            15. Stamens 2-3.......... *Sapium*
            15. Stamens numerous.......... *Jatropha*

### *Actephila* Blume

1. **Actephila Excelsa** (Dalz.) Muell.-Arg., in Linnaea

32: 78, 1863; FBI 5:282; Cooke, T. 2:575(3:71) *Anomospermum excelsum* Dalz. in Kew Journ. Bot. 3:228, 1851; Dalz. & Gibs. 233.

*Actephila neilgherrensis* Wight, Icon. t. 1910, 1852.

This species is known from a single collection of Chibber. We have not seen this species at Mahabaleshwar.

FLOWERS: August – September.

*Breynia* Forster (nom. cons.)

1. **Breynia Retusa** (Dennst.) Alston, Ann. Roy. Bot. Gard. (Peradenia) 11:204, 1929; T.P. Ramamoorthy, in Fl. Hassan Dist. 333, 1976.

*Phyllanthus retusus* Dennst., Schluess, Hort. Malab. 24, 1818.

*Melanthesa retusa* Kostel, Allg. Med.-Pharm. Flora 5:1771, 1835.

*M. turbinata* (Koen. ex Roxb.) Wight, Icon. 5(2):26, t. 1897, 1852; Dalz. & Gibs. 234; Santapau, 296, 1963.

*M. obliqua* Wight, Icon.t.1898, 1852.

*P. turbinatus* Koen. ex Roxb., Fl. Ind. 3:666, 1832; Graham, 180.

*B. patens* Rolfe, in Journ. Bot. (N.S.) 11:359, 1852; FBI 5:329; Cooke, T. 2:583(3:79); Birdwood, 25.

Quite frequent along roadsides along Kelgar Ghat.

FLOWERS: June–- July.

COMMON ENGLISH NAME: Cup-in-saucer plant.

*Bridelia* Willd.

1. Inflorescence axillary in clusters; stipules long and broad ........................................ *B.squamosa*
2. Inflorescence terminal and axillary spikes; stipules short and narrow ........................................ *B. retusa*

1. **Bridelia retusa** (L). Spreng., Syst. Veg. 3:48, 1826; FBI 5:268.1887; Cooke 2:572-3(3:68); Puri & Mahajan, 132. Cluytia retusa Linn. Sp. Pl. 1042, 1753.

*B. spinosa* Willd. Sp. Pl. 4:949, 1805; Graham, 184.

*B. montana* Graham, Cat. Bombay Pl. 184, 1839 (non Willd., 1905); Dalz. & Gibs. 233.

This species is included here on authority of Puri & Mahajan. In various herbaria, the specimens identified as belonging to this species have been now corrected as belonging to *B. squamosa* (Lamk.) Gehrm. We have not seen any authentic specimen of this species from Mahabaleshwar.

FLOWERS: March– May.

2. **Bridelia Squamosa** (Lamk.) Gehrm., in Engl. Bot. Jahrb. 41: Beilb. 95, 1908; Santapau, Fl. Khandala, ed. 3, 243, 1967.

*Cluytia squamosa* Lamk. Encycl. 5(2):54, 1790.

Occasional tree found along Fitzerald ghat and Kelgar ghat.

FLOWERS: December– May.

*Drypetes* Vahl

1. **Drypetes venusta** (Wight) Pax & Hoffm., in Pfreich. 81: 268, 1922; Santapau, Fl. Khand. ed. 3,247, 1967.

*Astylis venusta* Thwaites in Kew J. Bot. 7:272, 1855; Dalz. & Gibs. 229, 1861; FBI 5: 339, 1887; Cooke, 2:591(3:87).

A rare tree along Fitzgerald Ghat. There is only one specimen of this species in Blatter Herbarium from Mahabaleshwar area.

FLOWERS: November.

*Emblica* Gaertner

1. **Emblica officinalis** Gaertner, Fruct., 2:122, 1791; Dalz. & Gibs. 235; Wight, Icon. t. 1896, 1852; Puri & Mahajan, 132; Santapau, 295, 1963.

*Phyllanthus emblica* Linn. Sp. Pl. 982, 1753; Graham, 189; FBI 5:289; Cooke, T. 2:585 (3:81); Lisboa, 223; Birdwood, 25.

One of the common trees all over Mahabaleshwar in forest areas. Fruits used for pickles.

FLOWERS: March– May.

LOCAL NAMES: Aula, Amla.

*Glochidion* Forst.

1. **Glochidion hohenackeri** Bedd., For. Man. in Flora Sylvat. 193, 1873; FBI 5:514; Cooke, T. 2:579 (3:75); Puri & Mahajan, 132; Santapau, 399, 1962 & 295,6 1963.

*G. lanceolarium* Dalz. in Dalz. & Gibbs. Bombay Fl. 235, 1861 (non Voight, 1840).

*Bridelia sinica* Graham Cat. Bombay Pl. 184, 1839.

*B. lanceolaria* Roxb., Fl. Ind. 3: 697, 1832.

*Phyllanthus lanceolarius* Muell.-Arg. Fl. 48, 1865; Cooke, T. 648, 1885; Puri & Mahajan, 132.

*G. velutinum* auct. (non Wight, 1834); Santapau, 295, 1963.

Common tree all over on the plateau.

FLOWERS: December— March.

LOCAL NAMES: Bhoma, Boma.

### *Euphorbia* Linn.

1. Stems notdeveloped above ground; leaves all radical........................ 2
  2. Cyme single; bracts acute.................. *E. fusiformis*
  2. Cymes numerous from each stem; bracts rotundous.................. *E. panchganensis*
1. Stems well developed above ground.................. 3
  3 Perennial shrubs.................. *E.neriifolia*
  3. Annual herbs.................. 4
    4. Leaves exstipulate, at least lower ones alternate.................. *E. rothiana*
    4. Leaves stipulate or the leaf attachment connected by a transverse interpetiolar line, leaves opposite.................. 5
      5. Floral leaves distichously imbricating.................. 6
        6. Seeds tuberculate.................. *E. pycnostegia*
        6. Seeds smooth..... *E. pycnostegia* var. *zornioides*
      5. Floral leaves not distichously imbricating .................. *E. parviflora*

1. **Euphorbia fusiformis** Buch.-Ham. ex Don, Fl. Nepal. 62, 1825; FBI 5: 257; Birdwood, 26.

*E. acaulis* Roxb., Pl. Ind. 2: 472, 1828; Graham, 179; Dalz. & Gibs. 226; Cooke, T. 651 & 2:472 (3:57); Puri & Mahajan, 132.

Common deciduous perennial herb on exposed rocky ground at Wilson Point.

FLOWERS: April– May.

2. **Euphorbia neriifolia** Linn. Sp. Pl. 451, 1753; Dalz. & Gibs. 226; Lisboa, 25; FBI 5:255; Santapau, 295, 1963.

*E. liqularia* Roxb. Fl. Ind. 2:465, 1832; Cooke, T. 2:563 (3:58).

Occasionally used as a hedge plant.

FLOWERS: August– October.

LOCAL NAMES: Thor, Dudli.

3. **Euphorbia panchganensis** Blatter & McCann, Journ. As. Soc. Bengal, N.S. 26:353, 1930; santapau, 295, 1963.

Quite common in the same localities as the preceeding species. This species is distinguished from *E. fusiformis* Buch.–Ham. by its numerous cymes on a single stem and its rotundous bracts. We have observed that in the case of Mahabaleshwar plants these characters are very variable, giving all intermediate forms. Bracts in Mahabaleshwar plants vary from sharply acute to obtuse as well as orbicular in shape. Cymes in Mahabaleshwar plants vary from a single cyme to as many as ten. We have not been able to isolate any reliable differentiating character and feel that it is only a variable form of the preceeding species. But before merging these allied species or reducing them to varietal ranks as suggested by Rev. H. Santapau, in Revision of genus *Euphorbia* in Bombay (Bull. Bot. Soc. Bengal, 8:3-4, 1954), we feel that more field studies as well as more data on anatomy, cytology, palynology, etc. may be necessary to decide the status of these taxa.

4. **Euphorbia parviflora** Linn. Syst. ed. 10, 2:1047, 1759; Graham, 179; Dalz. & Gibs. 227; Santapau, 243,

*E. hypericifolia* Linn. Sp. Pl. 454, 1753 (p.p.); FBI 5:249 (p.p.); Birdwood, 25.

*E. hypericifolia* var. *parviflora* Prain, Bengal Pl. 2:924, 1903; Cooke, T. 2:567(3:63).

Common among grasses on rocky ground.

FLOWERS: August– September.

LOCAL NAME: Dudh– Mogra.

5. **Euphorbia pycnostegia** Boiss. Vent. Euphorb. 9, 1860; FBI 5:246; Cooke, T. 2:565(3:60); Birdwood, 25; Santapau, 241; Puri & Mahajan, 132.

Quite a common herb among the grasses at Lingmala.

FLOWERS: September – December.

6. **Euphorbia rothiana** Spreng., Syst. 3:796, 1826; Dalz. & Gibs. 226; Wight, Icon. t. 1864, 1852; Cooke, T. 651, 1885 & 2:565 (3:59-60); Lisboa, 222; Lee, 625; FBI 5:263; Birdwood, 25; Puri & Mahajan, 132; Santapau, Bull. Bot. Soc. Bengal, 8: 13, 1955.

Common and abundant herb along the edges of forests.

FLOWERS: September– October

FRUITS: October– April.

7. **Euphorbia pycnostegia** Boiss. var. **zornioides** (Boiss.) Santa- pau, in Bull. Bot. Soc. Bengal, 8:11, 1955.

*E. zornioides* Boiss., in DC. Prodr. 15(2): 19, 1862; FBI 5:246; Cooke, T. 2:265 (3:60); Birdwood, 25; Santapau, 295, 1963.

Quite a common herb among the grasses at Lingmala.

FLOWERS: August – November

### *Homonoia* Lour.

1. **Homonoia riparia** Lour., Fl. Cochinch. 637, 1790; FBI 5: 455; Cooke, T. 649 & 2:620 (3:118); Lisboa, 22; Birdwood, 25; Puri & Mahajan, 132.

*Adelia neriifolia* Roth., Nov. Pl. Sp. 375, 1821; Graham, 185; Dalz. & Gibs. 231; Wight, Icon. t. 1868, 1852.

Common shrub along sides of Yenna river.

FLOWERS: January – April.

LOCAL NAME: Taniki.

### *Jatropha* Linn.

1. **Jatropha curcas** Linn. Sp. Pl. 1006, 1753; Graham, 183; Dalz. & Gibs. suppl. 77; FBI 5:383; Cooke, T. 2:598 (3:95); Lisboa, 222.

Rarely used as a hedge plant.

FLOWERS: Throughout the year.

LOCAL NAME: Mogli Erand, Jambhal Erandi.

### *Kirganelia* Baill.

1. **Kirganelia reticulata** (Poir.) Baill. Etud. Gen. Euphorb. 613, 1858; Santapau, 246.

*Phyllanthus reticulatus* Poir. in Lamk. Encycl. 5:298, 1804; FBI 5:288; Cooke, T. 2:585 (3:81).

*Anisonema multiflora* Wight, Icon. t. 1899, 1852; Dalz. & Gibs. 234.

*P. multiflora* Willd. Sp. Pl. 4:581, 1805; Graham, 180.

Sarmentose shrub, rarely used as a hedge plant.

FLOWERS: April – October.

### *Macaranga* Thouars

1. **Macaranga peltata** (Roxb.) Muell.-Arg. in DC. Prodr. 15(2):1010, 1866; Santapau, 250.

*Osyris peltata* Roxb., Fl. Ind. 3:855, 1832; Graham, 177. Mappa peltata Wight, Icon. t. 817, 1844.

*Macaranga roxburghii* Wight, Icon. 5(2): 23, 1852;FBI 5: 448; Dalz. & Gibs. 228; Birdwood, 26.

*M. tomentosa* Wight, Icon. 5(2): 23, 1832; Cooke, T. 2:619 (3:117), 1906.

This species is reported on authority of Santapau. We have not seen an authentic specimen of the species from Mahabaleshwar.

### *Mellotus* Lour.

1. **Mallotus philippensis** (Lamk.) Muell.-Arg. in Linnea 34: 196, 1865; FBI 5:445; Cooke, T. 2:615 (3:113-4), 1906; Birdwood, 25; Puri & Mahajan, 132; Santapau, 295, 1963.

*Croton philippense* Lamk., Encycl. 2:206, 1786.

*Rottlera tinctoria* Roxb., Pl. Cor. 2:36, t. 167, 1798; Graham, 184; Dalz. & Gibs. 230.

Common tree on lower slopes of Fitzgerald Ghat.

FLOWERS: December– January

FRUITS: January– April.

LOCAL NAMES: Rohen, Asli.

### *Phyllanthus* Linn.

1. Annual herbs........ 2
    2. Stipules peltate........ *P. maderaspatensis*
    2. Stipules not peltate........ *P. asperulatus*
1. Perennial shrubs........ *P. lawii*

1. **Phyllanthus asperulatus** Hutchinson, in Kew Bull. 1920: Webster, in Journ. Arn. Arbor. 37:14, 1956; Santapau, 245. *P. niruri* auct. (non Linn., 1753); Graham, Cat. Bombay Pl. 180, 1839; Dalz. & Gibs. 234; Wight, Icon. t. 1894, 1853; Cooke, T. 2: 587 (3:84).

*P. fraternus* Webster, in Contrib. Gray Herb. 176 :53, 1955.

Quite common weed in wastelands in town.

FLOWERS: August– October.

LOCAL NAME: Bhui– Auli.

2. **Phyllanthus lawii** Graham, Cat. Bombay Pl. 181, 1839; FBI 5: 290; Cooke, T. 2:586 (3:82).

*P. polyphyllus* Dalz. & Gibs. Bombay Fl. 234, 1861 (non Willd, 1805); Lisboa, 223.

This species is reported here on authority of Lisboa. We have not seen it on the plateau, although it is found on the bed of Koyna river, below Mahabaleshwar.

3. **Phyllanthus maderaspatensis** Linn. Sp. Pl. 982, 1753; Graham, 180; Dalz. & Gibs. 233; Wight, Icon. t. 1895, f. 3, 1853; FBI 5:292; Birdwood, 25; Cooke, T. 2:586, (3:82).

Rare weed in shady places in wastelands.

FLOWERS: July– August.

### *Ricinus* Linn.

1. **Ricinus communis** Linn. Sp. Pl. 1007, 1753; FBI 5:457; Graham, 183; Dalz. & Gibs. suppl. 78; Lisboa, 223; Cooke, T. 2:627 (3:125); Puri & Mahajan, 132.

Rare shrub, occasionally found growing as a weed along roadsides near the bus-stand. Frequently cultivated in front of village houses.

FLOWERS: July– September.

LOCAL NAME: Erandi.

### *Sapium* R. Br.

1. **Sapium insigne** Benth. var. **malabaricum** (Wight) Hook. f., in flora Brit. India 5:472, 1885; Santapau, 296, 1963. *Falconeria malabarica* Wight, Icon. t. 1866, 1852. *Sapium insigne* Cooke, T. Fl. Bombay Pres. 2:622, 1906 (non Benth.).

Rare tree along Fitzgerald Ghat.

FLOWERS: January– April

FRUITS: March– June.

LOCAL NAME: Sherod.

### *Securinega* A. Juss.

1. Unarmed shrubs; leaves upto 7 cm. long......S. virosa
1. Armed shrubs; leaves upto 3 cm long.....S. leucopyrus

1. **Securinega leucopyrus** (Willd.) Muell.– Arg., in DC.Prodr. 15(2):451, 1866; Santapau, 296, 1963.

*Fluggea leucopyrus* Wild., Sp.Pl. 4:757, 1805; FBI 5:328; Wight, Icon. t. 1875, 1852; Cooke, T. 2:581 (3:77).

*F. virosa* Dalz. & Gibs. Bombay Fl. 236, 1861 (non Baill., 1858).

This species has been reported by Rev. Fr. H. Santapau, from Mahabaleshwar. We have not seen any authentic specimen from Mahabaleshwar.

2. **Securinenga virosa** (Roxb.) Pax & Hoffm., in Pfam. ed. 2, 19C:60, 1931; Santapau, 244.

*Phyllanthus virosus* Roxb., ex Willd. sp. Pl. 4:578, 1805.

*Flueggea microcrapa* Blume, Bijdr. 580, 1825.

*F. leucopyros* Dalz. & gibs. Bombay Fl. 236, 1861 (non Willd., 1805).

*P. retusus* Roxb., Fl. Ind. 3: 657, 1832; Graham, 180.

*Chorisandra pinnata* Wight, Icon. t. 1944, 1853.

*Fluggea virosa* Baill., Etud. Gen. Euphorb. 593, 1858.

Rare shrub along Fitzgerald Ghat.

FLOWERS: May– June.

LOCAL NAME: Pandharphali.

### *Tragia* Linn.

1. Leaves simple................................ *T. muelleriana* var. *unicolor*
1. Leaves palmately 3-partite.................................. *T. cannabina*

1. **Tragia cannabina** Linn.f. suppl. 415, 1781; Dalz. & Gibs. 228.

*T. involucrata* var *cannabina* Muell.– Arg. in DC. Prodr. 15 (2):944, 1866; FBI 5:465.

Rare climber along the edges of forests.

FLOWERS: May– June.

2. **Tragia muelleriana unicolor** var. (Muell.–Arg.) Pax & Hoffm. in Pfreich. 68:81, 1935; Santapau, 251.

*T. micheliana* var. *unicolor* Muell––Arg., in DC. Prodr. 15(2): 843, 1866.

*T. involucrata* Cooke, T. Fl. Pres. Bombay 2:621, 1906; (Pro parte); Birdwood, 25; Puri & Mahajan, 132.

Common stinging climber along the edges of forests. Stinging hairs cause blisters and dermatitis.

FLOWERS: September– December.

LOCAL NAMES: Churki, Khajkolti.

## SANTALACEAE

### *Osyris* Linn.

1. **Osyris guadripartita** Dalz. ex Decne., Ann. Sci. Nat. ser. 2, 6:65, 1836; Hendrich, in Fl. Europaea 1:70, 1964.

*O. wightiana* Wall. ex Graham, Cat. Bombay Pl. 177, 1839; Wight, Icon. t. 1853, 1852; Dalz. & Gibs. 223; Markham, 385; Cooke, T. 649, 1885, Santapau, 399, 1962.

*O. arborea* Wall. ex DC. Prodr. 14:633, 1857; FBI 5:32; Cooke, T. 2: 555(3:501); Birdwood, 25; Puri & Mahajan, 132.

Evergreen shrub, sometimes attaining height of a small tree. Common along edges of the forests in open places.

FLOWERS: Throughout the year.

LOCAL NAMES: Lotal, Popli.

# TERRITORIALITY IN INDIAN BLACKBUCK, *ANTILOPE CERVICAPRA* (LINNAEUS)[1]

N.L.N.S. PRASAD[2]

*(With a text-figure)*

Territoriality in blackbuck, *Antilope cervicapra*, was investigated for 2 years in six individually-identified territorial bucks at Mudmal, Andhra Pradesh. A total of 12 territories were maintained by these bucks at different times during the study period. Territory size varied from 3.33 ha to 16.65 ha with a mean size of 9.19 ha. The minimum territorial period was 5 weeks while the maximum was 9.5 months. Some of the bucks shifted their territories abruptly without changing to bachelor status in between. Territories were marked with urination-defecation and with preorbital glands. Interactions of territorial bucks with bachelors showed a higher percentage being directed against adults, due to apparent threat to the territory from them, than from other age groups.

## INTRODUCTION

Territorial behaviour by males is one of the fundamental forms of social behaviour exhibited by ungulates (Estes 1974). This social aspect has been well investigated in the wild as well as in captivity in many African antelopes. Studies in the wild on Thomson's Gazelle, *Gazella thomsoni* and Grant's Gazelle *G. granti* (Estes 1967, Walther 1972), Impala, *Aepyceros melampus* (Jarman and Jarman 1974), Sable Antelope, *Hippotragus niger* (Estes 1964, 1969; Estes and Estes 1976); and Springbok, *Antidorcas marsupialis* (Walther 1981) and captive studies on Blackbuck, *Antilope cervicapra* (Hediger 1941, Walther 1959, Mungall 1979); Gerenuk, *Litocranius walleri* (Leuthold 1978); Dorcas Gazelle, *Gazella dorcas* (Walther 1968) and Dama Gazelle, *G. dama* (Mungall 1980) are some of the earlier studies. The species studied so far show some common characteristics relating to territoriality, namely: a) only adult males become territorial, but not all of them, b) usually territorial periods alternate with non-territorial periods during the life of the same individual, c) owners aggressively exclude other males from their territories or at least dominate them within territorial boundaries, and d) usually females only temporarily visit males in their territories (Walther *et al.* 1983). There have been few scientific studies in the wild on this behavioural phenomenon of the Blackbuck. These include studies in Kanha National Park (Schaller 1967) and Velavadar National Park (Ranjitsinh 1982) in India and studies in Texas, U.S.A. (Cary 1976, Mungall 1978, 1979). This paper presents the territory size of six individually identified bucks in the wild at Mudmal, Andhra Pradesh, and aspects related to territoriality.

## STUDY AREA AND METHODS

The 80 km$^2$ study area (*c.*16°24'N, 77°27'E) was divided into 500 x 500 m grids on Survey of India maps scaled 1:33000. Cultivated fields and fallow lands occupied 81% of the area. The remaining 19% area was occupied by 4 different habitat types. These habitat types and utilization have already been described by Prasad and Ramana Rao (1984; in press). Features such as rocky elevations, boulders, grassy patches, rainfed tanks and patches of *Phoenix* sp. in the habitat served as landmarks for identification of grids.

Blackbuck were observed from April 1978 to February 1980. They could be easily approached upto a distance of 100 m, and at times even less, without being disturbed by the observer. By the end of the 2-year study, 11 adult bucks were recognized individually out of a population of 105 animals. Details of the population structure have been given by Prasad (1984). The shape of horns, the number of spirals in horns and the intensity of black colour on the coat were the criteria used in individual identification of bucks. Each buck was assigned an identification code such as PB I, PB II, LIMI, PPR I, etc. Of these, eight were territorial at one time or other. Data on bucks PPR II and PPR III was scanty and is hence not dealt with here.

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TABLE 1
TERRITORY SIZE AND TERRITORIAL PERIOD OF BLACKBUCK AT MUDMAL

| Territorial buck | Total sightings | No. of days territorial behaviour seen | Location on Fig. 1 | Territorial period (weeks) | Territory size (ha) |
|---|---|---|---|---|---|
| PB I | 265 | 13 | A | 11 Nov 1978-31 Jan 1979 (11) | 7.8 |
| | | 9 | B | 2 Feb 1979-13 Apr 1979 (10) | 13.0 |
| PB II | 336 | 18 | C | 12 Sep 1978-21 Mar 1979 (26) | 12.28 |
| | | 34 | D | 25 May 1979-17 Feb 1980 (38) | 16.65 |
| PPR I | 42 | 4 | E | 3 Feb 1979-2 May 1979 (14) | 7.80 |
| | | 5 | F | 10 Jun 1979-16 Jul 1979 ( 5) | 8.53 |
| LIMI | 349 | 8 | G | 15 Sep 1978-31 Oct 1978 ( 7) | 5.93 |
| | | 6 | H | 4 Nov 1978-27 Dec.1978 ( 8) | 11.86 |
| | | 20 | I | 4 Feb 1979-2 Oct 1979 (34) | 10.92 |
| LG III | 92 | 12 | J | 12 July 1979 -27 Nov 1979 (20) | 7.49 |
| PM I | 87 | 8 | K | Nov 1978 - 25 Feb 1979 (13) | 3.33 |
| | | 10 | L | 12 Mar 1979 - 18 May 1979 (10) | 5.41 |

Combined average of all territories: 9.19 ha.

All observations were carried out on foot during daytime and were aided by 8 x 30 and 8 x 40 binoculars. The places at which territorial behaviour was expressed by bucks on different days were identified on gridded maps. The behaviour patterns used for identifying territoriality were: expression of dominance by a buck over conspecifics of the same sex through fights and chases and attempts to drive them from a specified area; vigorous attempts to herd members of the opposite sex within this area; marking the area with urine, faeces, and preorbital gland secretion (Walther *et al.* 1983). The outermost points where territorial behaviour occurred in the study area during the observation period of individual bucks were joined by straight lines to form the boundary of the territory. The area of the territory was determined by tracing the boundary onto a graph paper to appropriate scale.

Dung piles used exclusively by territorial bucks PB I, LIMI, and LG III were identified individually. A paper tag was attached to a bush or a plant near the dung pile. This enabled me to record the visits of the bucks to the dung pile. The dung piles were measured and represented on the map.

A total of 269 days were spent from April 1978 through February 1980 and over 780 hrs. of observations made on the activity patterns of different animals. Observations on territorial bucks totalled 366 hrs. The number of hours of observations varied from 1-10 hrs. per day. The method of data recording was described in detail by Prasad (1985). $X^2$-test was performed to find seasonal differences in the interaction of territorial bucks with other members.

## RESULTS AND DISCUSSION

### Territories

The territories of all six bucks were on fairly elevated, open grassland. From these areas, the bucks could have a visibility radius of at least 1 km. This allowed them to see the activities of other blackbuck nearby. Due to the presence of fresh and palatable forage material in these areas and in adjacent cultivated fields and fallow lands they formed centres of blackbuck activity.

### Territorial period

The minimum period a buck was observed holding territory was five weeks (PPR I) while the maximum was 9.5 months (PB II; Table 1). Except for LG III, all other bucks changed the location of the territory to a new place at least once. At the beginning of the study, LG III was observed in a bachelor herd and became territorial only during July 1979. Most bucks appeared to shift territories on their own and were not driven from them by another male. LIMI maintained a territory in three different locations at different times (Table 1). On

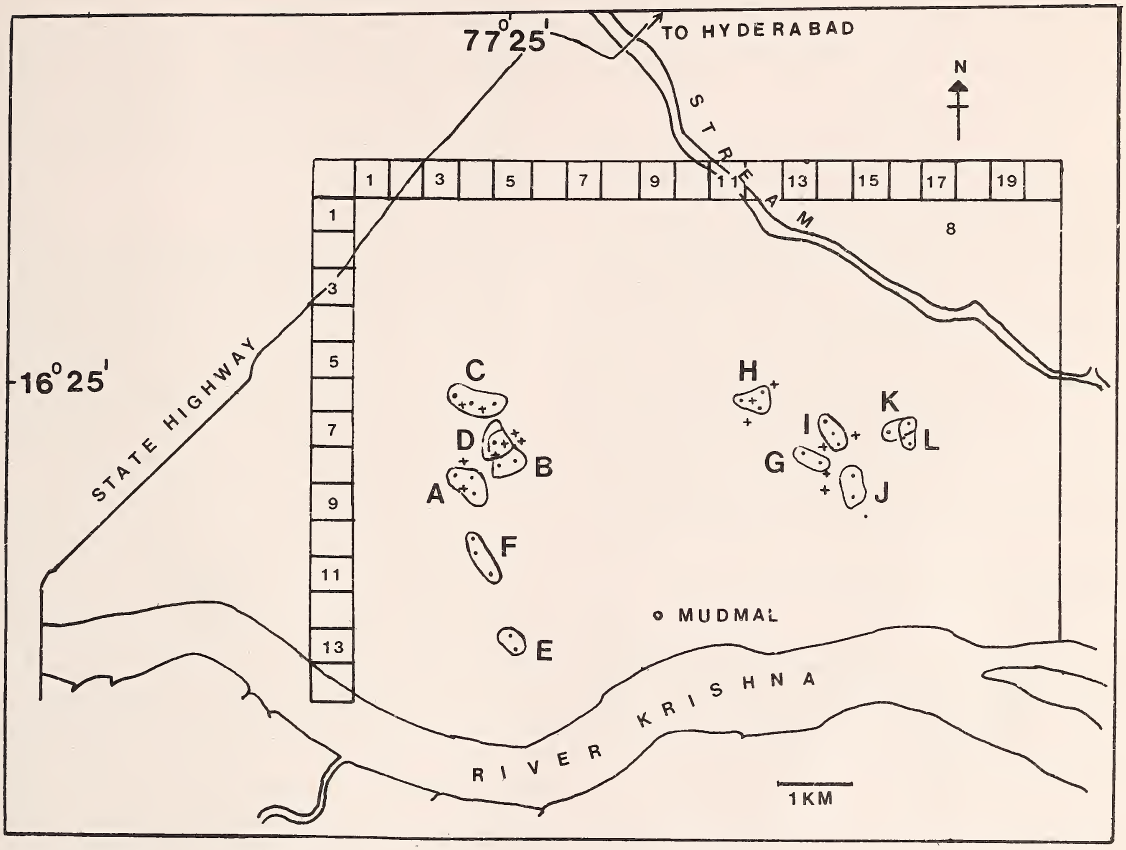

Fig. 1. Distribution of territories of six territorial bucks in Mudmal. A-L: Location of territories at different times (details in Table 1). Dot indicates dung pile location; plus indicates thrashing bushes/preorbital gland marking.

25 February 1979, during the ownership of territory at location I, he was passing near the territory K (PM I) and was seeing limping. He was chased away by PM I while the females accompanying LIMI strayed into territory K. In subsequent observations., LIMI was alone in an adjacent area which was not occupied by any other buck. On 4 April 1979, and later on, LIMI exhibited courtship behaviour within this area. Although he was seen within this territory during November 1979, courtship behaviour was not observed. On 30 December 1979, he joined a bachelor herd and was seen in association with them till 20 February 1980.

PB II changed the location of his territory from C to D on 25 May 1979 after the death of PB I. Part of this newly acquired territory belonged to PB I (Fig. 1). The change of place was mainly due to poor forage quality in the area and a decrease in number of females. On some occasions bucks were temporarily forced out of their territories by cultivators. Bucks returned as soon as the cultivators left the area and defended the same boundaries.

## Size and Shape

Territory size varied between 3.33 ha (PM I) and 16.65 ha (PB II; Table 1). The combined average of 12 territories (A-L; Fig. 1) of all bucks was 9.19 ha. PB I, PB II, LIMI and PPR I showed smaller size. The territories were either elliptical or triangular in shape. Boundaries of territories consisted of sheet rocks, streams, hedges of cultivated fields and uncultivated fields with *Phoenix* trees. These landmarks seem to limit the activity of bucks forming a boundary, which possibly enables them to recognize their territories.

Schaller (1967) reported a territory size of 8.09 ha in Kanha National Park, and Ranjitsinh (1982) measured territories ranging from 28 x 24 m (0.07 ha) to 380 x 290 m (11.02 ha) at Velavadar National Park, India. The size of 33 territories in Texas, USA, ranged between 1.2 and 12.8 ha with an average of 4.1 ha (Mungall 1979). Pasture size and distribution of suitable tracts of open pastures were found to determine the territory size. The largest sizes were 12.8 ha and 11.3 ha in large and small pastures respectively. Mungall (1979) also reported territorial periods ranging between 2 weeks and 11 months with an average of 4 months, which is comparable with the territorial periods at Mudmal.

### Behavioural patterns associated with teritoriality

Marking certain areas by urination-defecation and with preorbital glands had special significance in the establishment of blackbuck territorial boundaries. These behaviour patterns, although expressed by any adult buck, were more pronounced in the territorial bucks.

### Dung pile

Each buck had at least one dung pile within its territory. The dung piles were located either centrally or near the boundary of the territory. When there were more than two, the distance between them varied from 20 to 100 m. Dung piles were also maintained by non-territorial bachelor bucks outside territories. Dung piles were visited by bucks: 1) after the completion of bedding activity, which is a ritualised behaviour and may help the buck to assure its ownership of the territory, 2) before and after interaction with females and with adult bucks that would try to intrude into the territory, 3) when they were subjected to human disturbance, and 4) whenever they passed near the dung piles during other activities such as feeding. While using a dung pile, the buck approached it, perhaps sniffed, pawed it once or twice with a foreleg, then stood with hind legs stretched rearward and urinated. Later, he squatted and defecated. The whole ceremony lasted between 20 and 38 sec. (X=30.7; n=84). After this the buck usually lay down nearby. The distance from the place of bedding to the nearest dung pile varied between 5 and 150 m. Ranjitsinh (1982) and Mungall (1978), however, have documented many cases of territorial bucks lying directly on the dung pile. At Mudmal, the bucks were never observed to lie on the dung pile itself.

The maximum frequency of visits to a dung pile was two per day (LIMI). Some of the dung piles were not visited for 2 weeks. Their use was restricted to summer and winter. After the onset of monsoon in June, bucks stopped using them. However, territories were maintained by bucks during the rainy season as well. The temporary suspension of dung pile maintenance during the monsoon may be because rains wash off and negate the effect of the scent of the dung piles. Bucks started using them again during the last week of October, establishing a new dung pile very near the old ones. In some cases, however, the previously used ones were reestablished. A buck's dung piles may be used by another buck in the absence of the owner. Bucks scraped the dung piles, though either one or both urination and defecation were omitted on certain occasions. This scraping resulted in shallow depressions that were oval or round. The average maximum diameter was 86.5 cm when they were oval (n=16). The mean diameter of dung piles ranged between 53.3 cm and 75.3 cm. (n=29; Table 2). The maximum depth ranged from 8.5-15.0 cm. The depth depends mainly upon the number of visits, duration of use and the soil type in which it is located.

For comparison, Nair (1975) observed dung piles 80 cm long, 20 cm wide and 20 cm deep in Point Calimere; Ranjitsinh (1982) measured piles 2.0 m long and 1.6 m wide; Mungall (1978) reported an average diameter of 1 m (n=72), and when oval a maximum length of 4.7 m (n=66) in Texas, USA.

### Marking with preorbital glands

Preorbital gland marking by the territorial bucks was observed only on a few occasions (Fig.1). During preorbital gland marking, bucks thrashed small bushes or tufts of grass vigorously while chasing away the bachelors from their territories. Thrashing of bushes was also observed outside the

TABLE 2
DUNG PILE DATA OF TERRITORIAL BUCKS AT MUDMAL

| Territorial buck | No. of dung piles | Diameter (cm) | | Depth (cm) | |
|---|---|---|---|---|---|
| | | Maximum | Average | Maximum | Average |
| PB I | 6 | 74.0 | 59.6 | 13.0 | 12.0 |
| PB II | 4 | 84.0 | 57.33 | 8.5 | 8.2 |
| PPR I | 4 | 59.0 | 53.5 | 9.0 | 8.3 |
| LIMI | 8 | 86.5 | 75.3 | 15.0 | 12.0 |
| PM I | 4 | 61.2 | 52.4 | 11.0 | 8.6 |
| LG III | 3 | 76.0 | 60.5 | 10.0 | 9.2 |

territories. Marking with preorbital gland in these areas of bushhorning have not been noticed. Such activities, although less frequent, were also exhibited by non-territorial bucks.

### Interactions of territorial bucks with other members

Serious fights between territorial males were very rare. A territorial male would resort to fighting with adults when his challenging threat displays did not drive away the intruder. In most cases the owner of the territory would succeed. A total of 1482 interactions of various types between various sex and age groups were recorded during the study period of which 910 (61.4%) were by territorial males, 260 (17.5%) by adult males, 118 (7.9%) were by adult and subadult females, 106 (7.2%) were by subadult males and the rest by adolescent males and fawns (Table 3). This reveals that territorial bucks are socially more active than others.

Over 900 interactions were observed in which territorial bucks addressed females and males of various age groups (Table 4). Of these, 42.2% were with adult and subadult females, involving pursuit walk, head-up, nose-up displays and other courtship activities. The proportion of interactions with females in three seasons is significantly different ($X^2 = 22.65$; $p < .05$) with a peak in summer. This could be because more females come into heat in this season. Serious fights between territorial neighbours were very few (3.85%). Territorial bucks addressed adult bucks more frequently (27.14%) than bucks of other age groups, apparently due to an immediate threat to their territory. This, however, is not significantly different, nor are there seasonal differences ($X^2 = 5.87$; $p > 0.05$). Interactions in which a territorial buck was an addressee and an adult buck an addressor were only 2.31%. Territorial bucks addressed adolescent bucks more often (16.37%) than subadult bucks (9.56%).

## CONCLUSIONS

Blackbuck territories are reproductive territories (Mungall 1978). For maximum reproductive success, a territorial buck should occupy an area that is more frequently used by females. The location of territories in all the cases in the present study agrees with this. Once a buck establishes a territory, he may try to enlarge this area to the extent he can defend the territory against the intrusion of conspecific males.

Bucks shift the location of a territory to a new place when the area currently maintained attracts fewer females due to deteriorating habitat conditions.

A territorial buck faces threat mainly from other adult bucks. Hence he resorts to more frequent encounters with them than with younger males, to keep them off his territory.

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TABLE 3
% INTERACTIONS INVOLVING HEAD-UP, NOSE-UP, BUTTING IN MALES AND FEMALES DURING 1978-80

| | ADDRESSEE | | | | | | |
|---|---|---|---|---|---|---|---|
| ADDRESSOR | Territorial male | Adult male | Subadult male | Adolescent male | Fawn | Adult & sub-adult female | TOTALS |
| Territorial male | 3.85 | 27.14 | 9.56 | 16.37 | 0.66 | 42.42 | 100<br>(910) |
| Adult male | 2.31 | 30.0 | 16.15 | 13.08 | 7.69 | 30.77 | 100<br>(260) |
| Subadult male | 0.0 | 0.0 | 59.43 | 24.53 | 4.72 | 11.32 | 100<br>(106) |
| Adolescent male | 0.0 | 0.0 | 25.93 | 59.26 | 14.81 | 0.0 | 100<br>(54) |
| Fawn | 0.0 | 0.0 | 0.0 | 0.0 | 100.00 | 0.0 | 100<br>(34) |
| Adult & subadult female | 0.0 | 0.0 | 0.0 | 0.0 | 39.83 | 60.17 | 100<br>(118) |

Total interactions are given in parenthesis

TABLE 4
% INTERACTION OF TERRITORIAL BUCKS WITH OTHER BLACKBUCK DURING 1978-80 AT MUDMAL

| Season | Territorial buck | Adult bachelor buck | Subadult bachelor buck | Adolescent buck | Fawn subadult female | Adult & | Total |
|---|---|---|---|---|---|---|---|
| Summer | 1.41 | 28.78 | 10.85 | 9.90 | 0.00 | 49.06 | 212 |
| Monsoon | 4.81 | 22.12 | 10.10 | 15.14 | 0.96 | 46.87 | 416 |
| Winter | 4.26 | 33.33 | 7.80 | 23.05 | 0.71 | 30.85 | 282 |
| Whole year | 3.85 | 27.14 | 9.56 | 16.37 | 0.66 | 42.42 | 910 |

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# FIELD GUIDE TO THE AMPHIBIANS OF WESTERN INDIA[1]
## PART 4

J.C. DANIEL AND A.G. SEKAR[2]

*(Continued from Vol. 72 (2): 522)*

*(With six text-figures and two plates)*

Part 3 of this serial described frogs of the subgenera *Rana* and *Tomopterna* of the genus *Rana*. In this section we describe species of the subgenera *Discodeles* and *Hylorana* of the Family Ranidae and tree frogs of the family Rhacophoridae.

### Subgenus *Discodeles*

Tips of fingers and toes dilated into discs. Tongue with a large retractile papilla in the middle (Fig. 1 a.) In western Ghats six species are available and those can be separated by the following key.

#### KEY TO THE SPECIES OF *Rana (Discodeles)* IN WESTERN INDIA

1. Toes 1/2 to 2/3 webbed (see fig. 2 c & d)........ 2
1. Toes not more than 1/4 webbed (see fig. 2b)........ 3
2. First finger shorter than second; tympanum 2/3 diameter of the eye ........ *leithii*
2. First finger at least as long as second; tympanum 1/2 to 2/3 diameter of the eye........ *beddomii*
2. First finger longer than second; tympanum as large as eye and close to it ........ *semipalmata*
3. Tympanum very distinct; loreal region very oblique; skin of head smooth, of back with short longitudinal folds; no lumbar spot........ *leptodactyla*
3. Tympanum distinct; loreal region feebly oblique; skin of head smooth; of back with short longitudinal folds; a black lumbar spot ........ *diplosticta*
3. Tympanum moderately distinct; head and back with large warts ........ *phrynoderma*

**Rana leithii** Boulenger, 1888: Leith's Frog

**Diagnosis:** Small sized frogs; largest specimen in the *BNHS* collection measured 38 mm. The bifid tongue has a distinct papilla, Head moderate; snout obtuse. Interorbital width a little narrower than the upper eyelid; tympanum 2/3 the diameter of the eye. First finger not extending quite as far as second; toes 2/3 webbed. Tips of fingers and toes dilated into small discs with circum-marginal groove. Tibio tarsal articulation reaching between the eye and the tip of the snout; inner metatarsal tubercle oval; no tarsal fold. The heels overlap when the limbs are folded at right angles to the body.

Skin of back with small scattered longitudinal warts; a strong fold from the eye to the shoulder.

**Colour:** Brown above with small dark spots; limbs with dark tranverse bands, lower parts white; throat mottled with brown. Specimens seen in Matheren by Abdulali and Daniel (1954)[3] showed variation some being dark grey, blackish or paler and some with golden patches.

**Distribution:** Occurs along the Western Ghats from Surat Dangs, Gujarat in the north, southward to Central Kerala.

**Breeding:** The breeding season coincides with SW monsoon. Specimens collected in June from Matheran and Kanheri caves had well developed gonads. Tadpoles were collected at hill-streams on rocks wetted by spray. Very active and agile jumping several centimetres on the slippery surfaces. The coloration matches so well the dark grey of the rocks that it is very difficult to distinguish them (Daniel and Shull 1964)[4]. They attain 44.0 mm in total length. Tail 2.5 times the length of body. Dental formula is 1:3+3/2+2:2.

**Habits:** The species is found at moderate elevation and lives under stones and among ground litter during the day. Mc Cann (1932)[5] noted that the frog was not uncommon in short grass and in ditches on hill sides and appears to be diurnal, at least during the rains. It was frequently seen hopping about in the grass.

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[1] Accepted February 1989.

[2] Bombay Natural History Society, Hornbill House, Shaheed Bhagat Singh Road, Bombay-400 023.

[3] ABDULALI, , H. & DANIEL, J.C. (1954): Distribution of *Rana leithii* Boulenger- A correction. *J. Bombay nat. Hist. Soc. 52:* 635.

[4] DANIEL, J.C. & SHULL, E.M. (1964): A list of the Reptiles and Amphibians of the Surat Dangs, South Gujarat. *J. Bombay nat. Hist. Soc. 60:* 737-743.

[5] MCCANN, C. (1932): Notes on Indian Batrachians. *ibid. 32:* 152-180

### **Rana beddomii** (Gunther, 1875), Beddome's Frog

**Diagnosis:** Medium sized frogs, the largest specimen in the *BNHS* collection has a snout to vent length of 50 mm. This species closely resembles *Rana leithii* but can be separated by the following characters: Inter orbital space as broad as the upper eyelid. Fingers moderate. First at least as long as second. The tibio-tarsal articulation reaches the tip of the snout or a little beyond. The heels strongly overlap when the limbs are folded at right angles to the body.

Skin of back with short longitudinal glandular folds; a strong fold (supra tympanic fold) from the eye to the shoulder.

**Colour:** Brown above with rather indistinct darker spots rarely uniform pinkish; sometimes a light vertebral band; a dark cross band between the eyes; a black band along the canthus rostralis and a black temporal spot; limbs more or less distinctly cross-barred; lower parts uniform white.

**Distribution:** Specimens in *BNHS* collection from North Kanara, Talewadi in Karnataka; Munnar, Alwaye Ghat, Periyar lake, South Travancore in Kerala; Palni Hills, Courtalum in Tamil Nadu.

**Breeding:** Males without vocal sacs with an enlarged pad on the inner side of the first finger. Specimens collected between December and June have mature gonads. Tadpole remarkable for its long tail, 3 times the length of the body (Boulenger, 1920)[6] Tadpoles collected from rock faces made short, skittering jumps across the rock faces whenever they were closely approached. The principal function of this behaviour is to enable the tadpoles to move from one tiny, shallow pool to another across slightly drier surface irregularities of the home rock face. Dental formula is 4 + 4/2 + 2:2 (Inger *et al.* 1984)[7].

**Habits:** Little known. The species is extremely common and lives under rocks in flowing streams, many of which held a luxuriant growth of *Ammania floribunda*. In the field it appears very like *R. leithii* (common at Panchgani, 1400 m), but *R. beddomii* keeps more to the wet rocks and flowing water than *leithii* , which is often found in grass at the top of hills or alongside hill streams. Frequently seen during the day but more abundant at night (Abdulali & Daniel 1954)[8]. Inger *et al* (op. cit.) collected the specimens from different types of forest, banks of permanent streams, dry stream beds, rocks, dead leaves etc.

### **Rana semipalmata** Boulenger, 1882

**Diagnosis:** Small sized frogs measuring upto 28 mm in snout to vent (*BNHS* collection). Bifid tongue with a papilla in the middle. Head moderate; snout blunt. Inter orbital width as broad as the upper eyelid or a little narrower. Tympanum equal to the diameter of eye. First finger a little longer than the second; Toes half webbed; Tips of fingers and toes dilated into disks with circum-marginal groove. Subarticular tubercles well developed; a single small oval inner metatarsal tubercle; no tarsal fold. Tibio-tarsal articulation reaching the tip of the snout or between the eye and snout. The heels overlap when the limbs are folded at right angles to the body.

Skin of back with short longitudinal glandular folds; sides granulate with small warts, a strong glandular fold from the eye to the shoulder; lower parts smooth. Mature males have nuptial pads on the first finger and enlarged glands covering the ventral surface of the thighs.

**Colour:** Brown above, sides of body darker, loreal and temporal regions blackish, limbs with dark crossbars, lower parts white, throat and breast mottled with brown.

**Distribution:** Malabar and Anamalai hills, Kerala, South India. Specimens in BNHS collected from Pullooranpara, Calicut in Kerala and Poombarai, Kodaikanal in Tamil Nadu.

**Breeding:** Unknown.

**Habits:** This species is found in evergreen and moist deciduous forest upto 360 m elevation; specimens collected from small permanent streams, dead leaves and rocks (Inger *et al.*, 1984).

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[6] Boulenger, G.A. (1920): A monograph of the South Asian, Papuan, Melanesian and Australian frogs of the genus *Rana*. *Rec. Indian Mus. 20:* 1-226.

[7] Inger, R.F., Shaffer, H.B., Koshy, M. & Bakde, R. (1984): A report on a collection of Amphibians and Reptiles from the Ponmudi, Kerala, South India.. *J. Bombay nat. Hist. Soc. 81:* 406-427, 551–570.

[8] Abdulali, H. & Daniel, J.C. (1954): Some notes on *Rana beddomii* Gunther with an extension of its range. *ibid.* 52:938.

### **Rana leptodactyla** Boulenger, 1882

**Diagnosis:** Small sized frogs; measuring upto 23 mm (male) in the *BNHS* collection. Tongue with papilla. Head depressed snout blunt. Interorbital width as broad as or little narrower than the upper eyelid. Tympanum 2/3 diameter of the eye. First finger shorter than second; toes 1/4 webbed. Tips of fingers and toes dilated into discs. Tibio-tarsal articulation reaching the tip of the snout or beyond. Heels overlap when the limbs are folded at right angles to the body.

Skin of the back with short longitudinal glandular folds; a fold from the eye to the shoulder.

**Colour:** Olive or brownish above, white uniform ventrally or spotted with brown, sometimes brown dotted with white.

**Distribution:** Forests of Malabar,. Anamalais, Travancore (Kerala); Kodaikanal, Palni hills (Tamil Nadu) and Coorg (Karnataka).

**Breeding:** Specimens collected in April and May in Kodaikanal had well developed testes. Annandale (1918)[9] collected the tadpoles in a small pool at the edge of a jungle stream in the hills in September. Tadpoles normal in shape. Total length was 31 mm. The mouth disc remarkably lacks horny teeth.

**Habits:** Unknown.

### **Rana diplosticta** (Gunther, 1875)

**Diagnosis:** Closely resembles *Rana leptodactyla*, measures upto 25 mm (female). The canthus rostralis is rather more angular and the loreal region not quite so oblique. Toes less than 1/4 webbed; fingers and toes with large discs with strong circum–marginal groove. Tympanum well developed, about 1/2 of eye diameter. Males have a series of 5 very large, black, sharp nuptial spines on the medial surface of the first finger (Inger *et al.*, 1984).

Skin with a series of interrupted, longitudinal, glandular folds on the back. The head, sides and belly are smooth. A strong curved supratympanic fold from eye to shoulder.

**Colour:** Reddish brown dorsally, with a black canthal and tympanic streak. Entire loreal region from canthus rostralis to upper lip is dark brown. Dark brown blotches may be present on the lateral surfaces. Ventrally light brown diffused with a fine reticulated pattern of dark brown. A black spot above the loin on each side. Limbs tan crossbarred with dark brown.

**Distribution:** Malabar, Kerala and forest of Srivilliputtur in Tamil Nadu.

**Breeding:** Unknown.

**Habits:** Inger *et al.* (1984.) collected the specimens at 950 m elevation, far from streams or ponds in ever green forest and gallery forest, under dead leaves, on bare soil and rock.

### **Rana phrynoderma** Boulenger, 1882

This species occurs at Anamalai Hills measured 30 mm. Not available in the *BNHS* collection.

### Subgenus *Hylorana*

Tips of toes or both fingers and toes dilated into discs, with circum-marginal groove (Fig. 1b). Tongue without a papilla; outer metatarsals usually separated by web to the base (Fig. 2e). Three species are described from western India.

#### KEY TO THE SPECIES OF *Rana (Hylorana)* OCCURRING IN WESTERN INDIA.

1. Discs of fingers, if present, without groove or the groove indistinct ........ *curtipes*
1. Discs of fingers bearing a groove separating the upper from the lower surface ........ 2
2. Tibio-tarsal articulation reaching between eye and the nostril (Fig. 3a) ........ *aurantiaca*
2. Tibio-tarsal articulation reaching nostril or tip of snout, or a little beyond (Fig. 3b) ........ *temporalis*

### **Rana curtipes** Jerdon, 1853, Bicoloured Frog

**Diagnosis:** Medium sized frog. Adult in the *BNHS* collection 74 mm (female) in snout to vent length. Head depressed, snout obtusely pointed, canthus rostralis distinct. Loreal region concave. Interorbi-

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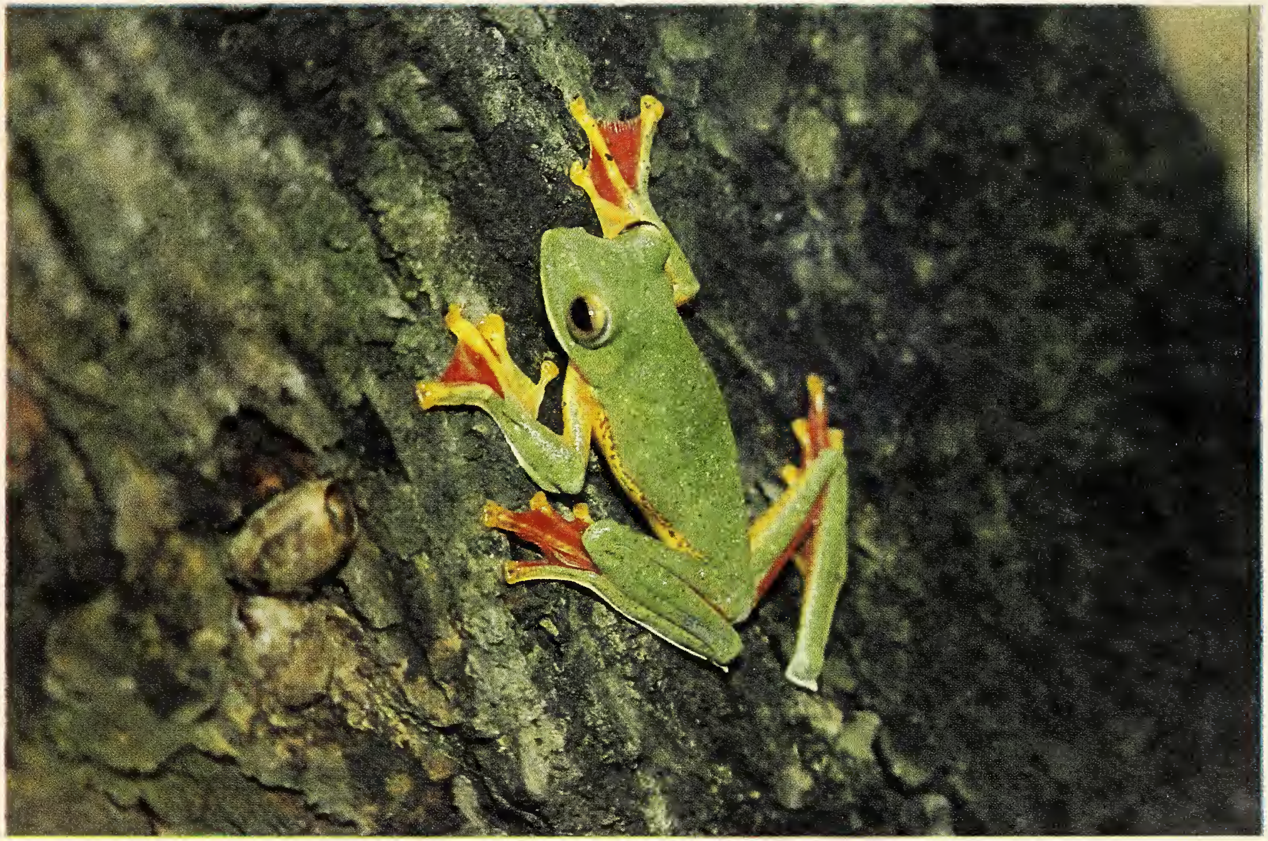
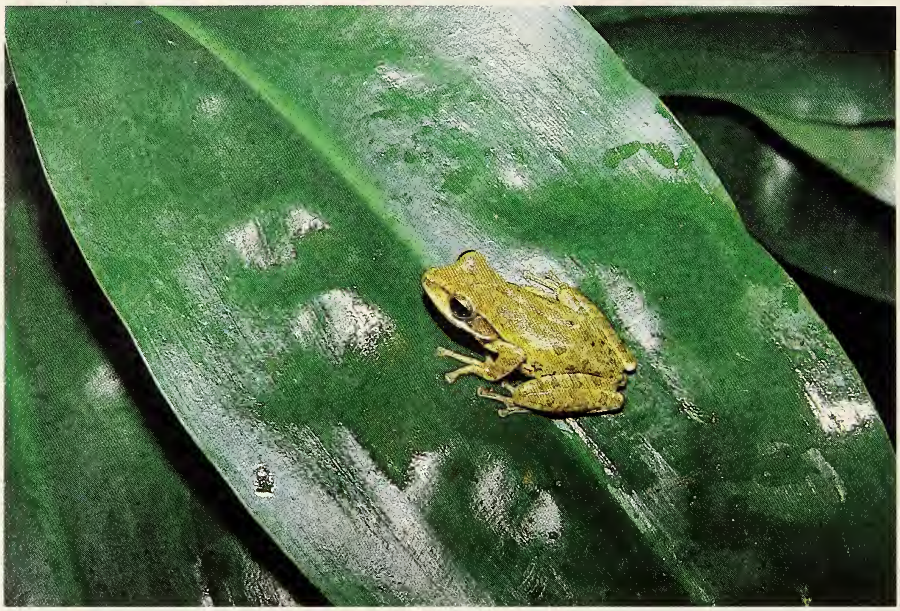
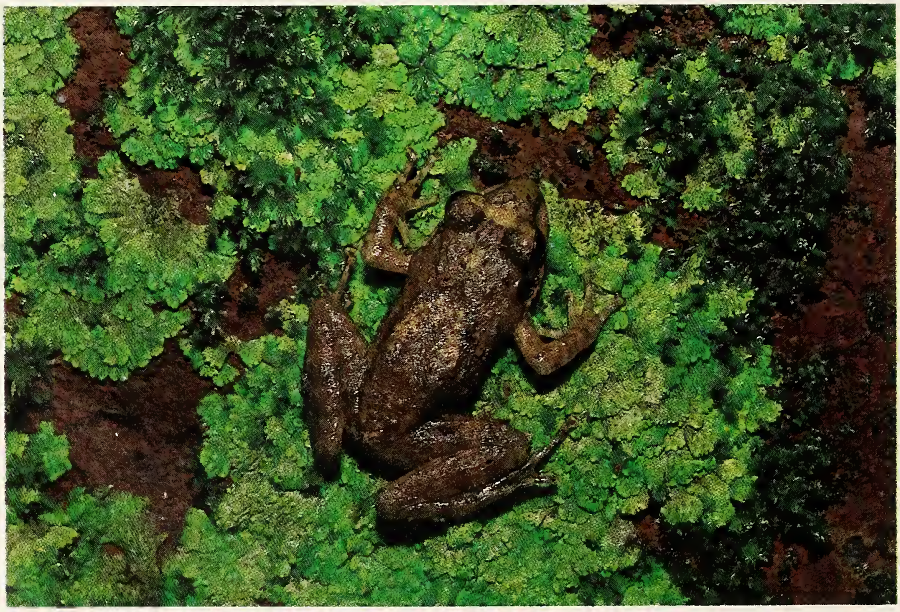
[9] ANNANDALE, N. (1918): Some undescribed Tadpoles from the hills of South India, *Rec. Ind. Mus. 15:* 19.



*Rhacophorus malabaricus*, Malabar Gliding Frog. (*Photo*: I. Kehimkar)





*Above*: *Polypedates maculatus*, Common Tree Frog (*Photo*: A. G. Sekar)
*Below*: *Rana leithi*, Leith's Frog (*Photo*: I. Kehimkar)

tal width broader than upper eyelid. Tips of fingers and toes swollen or dilated into discs with indistinct circum-marginal groove. First finger longer than second. Tibio–tarsal articulation reaches the tympanum or eye. Heels meet when the limbs are folded at right angles to the body; toes 3/4 or entirely webbed; inner metatarsal tubercle small; no tarsal fold. Males with internal vocal sacs with the fore limb more robust and a small patch of grey velvety rugosities on the inner metacarpal tubercle and on the inner side of the first finger.

Skin smooth; narrow, moderately prominent glandular dorsolateral fold; another fold behind the tympanum down to the shoulder.

**Colour:** The coloration is distinctive: grey above with or without black dots and black below. Both colours are sharply separated.

**Distribution:** Hills of North Canara (Karnataka), Malabar, and Travancore (Kerala). Specimens from Papanasam, Tirunelveli Dist., Tamil Nadu also seen in the *BNHS* collection.

**Breeding:** The frogs enter the water during the breeding season, which begins with southwest monsoon, Rao (1914)[10] has reported that the males, which are smaller, are very lively and their call notes may be denoted by the short syllables 'Thrub, Thrub' quite characteristic of the species. The large sized tadpoles which move in shoals are plentiful in small jungle streams and occur in April, May & June. The tadpoles are distinctive, being black with a pinkish red well marked glandular patch behind the eye. The maximum total length is 94.0 mm. Dental formula is 2: 4 + 4/1 + 1:5. Enormous numbers of the metamorphosed young occur on the banks of the many inlets of the Periyar Lake in the summer months and are eaten by the Wild Boar (*Sus scrofa*) (V.S. Vijayan , *pers. comm.*)

**Habits:** It is not essentially aquatic; and is found under stones and dry vegetation on damp soil along streams. They are uncomfortable in water. According to Abdulali (1962)[11] the adults are sluggish in their movements.

### **Rana temporalis** (Gunther, 1864), Bronzed Frog

**Diagnosis:** Medium sized frog. Adult in the *BNHS* collection measured 82 mm (female) in snout to vent length. Head depressed; snout acute, projecting beyond the mouth; canthus rostralis angular; loreal region strongly concave. Interorbital width broader than upper eyelid. Tympanum very distinct 3/4 the diameter of the eye. Tips of fingers and toes dilated into well developed discs with distinct circum-marginal groove. First finger longer than second. Toes nearly entirely webbed; inner metatarsal tubercle small; no tarsal fold. Tibio-tarsal articulation reaches nostril or tip of snout or a little beyond.

The heels strongly overlap when the limbs are folded at right angles to the body. Males with internal vocal sacs with the fore limb strong and a large flat gland on the innerside of the arm; a strong pad on the innerside of the first finger, covered during the breeding season with a greyish brown velvet like horny layer.

Skin smooth; a prominent glandular dorsolateral fold from above the tympanum to the hip. Lower parts smooth.

**Colour:** Yellowish brown to dark bronze above; limbs with dark brown cross bands; dorso-lateral fold usually with a dark outer edge; a dark brown, or black streak below the canthus rostralis continued on the temporal region, and some times on theside of the body. Lower parts white, uniform or spotted with brown on the throat and breast.

**Distribution:** Specimens in *BNHS* collection from Mahabaleshwar, (Maharashtra); Kaller base of Ponmudi Hill, Travancore (Kerala); Papanasam and Nilgiris at *c* 2000 m (Tamil Nadu).

**Breeding:** Specimens collected between October and December have well developed gonads. Abdulali (1954)[12] reported that there is some variation in the calls, but the commonest starts with a guttural croak followed by a series of 'tuk-tuk-tuks'. They call both day and night and are quite active during the day. He also observed the egg mass in a small pool in the course of the rock– strewn stream. The several masses of eggs were attached to the bottom or sides, all a few centimetres below water. Total length of the tadpole was 33.8 mm. Dental formula is 1: 1 + 1/1 + 1:2. Head and body dark without distinct pattern dorsally and laterally; tail also dark, with small scattered black spots (Inger *et al*, 1984).

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[10] RAO, C.R.N. (1914): Larva of *Rana curtipes*, Boul. Rec. Ind. Mus. *10:* 265

[11] ABDULALI, H. (1962): An account of a trip of the Barapede cave, Talewadi, belgaum District Mysore state with some notes on Reptiles and Amphibians. *J. Bombay nat. hist. Soc. 59:* 228-237.

[12] ABDULALI, H. (1954): Extension of Range of *Rana temporalis* Gunth. *J. Bombay nat. Hist. Soc. 52:* 636-637.

**Habits**:The species is found on wet exposed rocks in small hill streams shaded by bushes. It leaps for a considerable distance into the water when disturbed. Very common during the day at the waterfall at Mahabaleshwar. A female frog contained 2 small frogs and a pebble in her stomach, while a male contained a *Rana limnocharis* (Abdulali 1962)[11].

### **Rana aurantiaca** Boulenger, 1904 Golden Frog

**Diagnosis:** Small to medium sized frog; measuring 38 mm in snout to vent length. Slender. Snout long and narrow canthus rostralis distinct; loreal region vertical. Interorbital width very slightly broader than the upper eyelid. Tympanum distinct; 1/2 or 2/3 the diameter of the eye. Tips of fingers and toes dilated into discs with circum–marginal groove. Toes 2/3 webbed; Subarticular tubercles moderate; the outer matatarsal tubercle small and round whereas the inner elongated. Tibio–tarsal articulation reaches between eye and the nostril. Males have a darkly pigmented humeral gland close to the axilla and an internal vocal sac. A nuptial pad is present on the 1st finger.

Skin smooth or coarsely shagreened with an irregular scattering of conical tubercles. A distinct but narrow dorsolateral glandular fold extends from behind the eye to the region of the vent. Below this fold is a broad chocolate brown band which runs from the tip of the snout through the nostril eye and tympanum and fades on the flanks. Throat speckled and the vent is immaculate.

**Colour:** Orange above without spots on the back or bars on the limbs; a black band along each side of the head and body; upper lip; canthus rostralis and dorsolateral fold white; terminal discs of toes black, lower parts white.

**Distribution:** Type collected at Trivandrum, Kerala. Other specimen from Kadnjarkhana, South Kanara, Karnataka.

**Breeding:** Unknown, except the call.The frog calls from the undergrowth at a heigh t of 15–25 cm from the ground, and the call is syllabilised as 'chick-chick-chick'

**Habits:** Specimens have been collected from a slow stream and in a pool surrounded by undergrowth in a very wet area of rain forest.The descriptions and habits is based on Grandison and Senanayake (1966)[13]

### *Family: Rhacophoridae* Hoffman, 1932 (1859)
### Tree Frogs

The family Rhacophoridae consists of small to large sized frogs (20–100 mm in snout to vent length) and is primarily of the Oriental region. However, several members of this family have been reported from Madagascar and a single genus *Chiromantis* from Africa. In India, the family Rhacophoridae comprises two subfamilies (*Rhacophorinae, Philautinae*) and five genera (*Rhacophorus, Polypedates, Philautus, Chirixalus* and *Theloderma*). The members of the family are arboreal frogs having sticky digital pads; usually inhabit the dense forests of the Western Ghats and the Eastern Himalayas. The genera *Rhacophorus, Polypedates* and *Philautus* occur in the Western Ghats area.

Frogs of this family have horizontal pupil; free and deeply notched tongue. In many species of *Rhacophorus* elaborate dermal ornamentations such as flap on fore arm and heel are present. Digit tips are distinctly dilated into discs, with the digital pads having a circum–marginal groove. Webbing of fingers variable but generally extensive. Vocal sacs present. An intercalary ossification between the penultimate and distal phalanges.

KEY TO THE SUB-FAMILIES OF FAMILY RHACOPHORIDAE

Vomerine teeth present (Fig.4)..........................*Rhacophorinae*
Vomerine teeth absent.............................................*Philautinae*

### Sub-family: Rhacophorinae
### Hoffman, 1932 (1859)

Four species grouped under two genera are recorded from Western India.

KEY TO THE GENERA OF RHACOPHORINAE

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[13] GRANDISON, A.G.C. & SENANAYAKE, F.R. (1966): Redescription of *Rana (Hylarana) aurantiaca* Boulenger Amphibia: Ranidae. *The Ann. & mag. of Nat. Hist. 9:* 419-421.

## CORRECTION

Key to the genera of Rhacophorinae: read as follows:

KEY TO THE GENERA OF RHACOPHORINAE

Fingers with a slight rudiment of web (Fig. 6) . . . . . . . . . . . . . . . . . . . . . *Polypedates*

Fingers with a distinct web (Fig. 6) . . . . . . . . . . . . . . . . . . . . . *Rhacophorus*

Dermal fold along the forearm absent..................... *Polypedates*
Dermal fold along the forearm present (Fig. 5)..... *Rhacophorus*

### Genus *Polypedates* Tschudi, 1838

Species of this genus are moderate to very large in size, ranging from 50 to 100 mm in snout - vent length. Skin of body and limbs smooth; in many species skin of skull co-ossified to either fronto-parietal, nasal or squamosal bones. Dermal ornamentations generally absent; digital discs large; usually fingers only webbed at base, nuptial pads always present in males. Vomerine teeth always present.

### **Polypedates maculatus** (Gray, 1834)
### Common Tree Frog.

**Diagnosis:** A slender, medium sized frog. Adults in the *BNHS* collection 50 mm male; 79 mm female in snout-vent length. Vomerine teeth in two more or less oblique series between the internal opening of the nostrils. Skin of head free; a bony arch may be present. Snout obtusely acuminate as long as the diameter of the eye; canthus rostralis distinct; inter orbital width broader than the upper eyelid; tympanum about 3/4 the diameter of the eye; first finger as long as second; fingers with a rudiment of web (Fig. 6a). Toes 3/4 webbed (Fig. 2f). Tips of fingers and toes dilated into discs; discs of the third finger 1/2 or 1/2 the diameter of the eye. Subarticular tubercles well developed. Inner metatarsal tubercle prominent. Tibiotarsal articulation reaches the nostrils. Heels strongly overlap when the legs are folded at right angles to the body. Males with single vocal sac.

Skin smooth above, granulate on the belly and under the thighs a fold from the eye to the shoulder.

**Colour:** Brownish, yellowish, greyish or whitish above with darker spots; and hour glass shaped figure on the back may present; hinder side of thighs with round yellow spots which are usually separated by a dark brown net work. The species has the ability to change its colour to a certain extend to merge with its surroundings.

**Distribution:** Throughout India except Haryana, Punjab and Rajasthan.

**Breeding:** The tree frog breeds in the monsoon season. The activities begin just before the onset of monsoon. They select a wide range of breeding sites. Trees hanging over the water tanks or pools, rocks, moist ground and grass clumps are used as spawning sites. The call, generally, is heard after sunset, but they call also during the day after heavy showers. The call can be syllabilised as 'tak-tak ---- tak-tak-tak'. This type of note is produced only when the vocal sac is inflated to its full extend. Another call note can be syllabilised as 'dodo-dodo- dodo'. This note is produced when the vocal sac is partially inflated. Individual frogs can call continuously for 15 to 22 seconds.

Amplexus is axillary; the male holds the female at her armpit. The foam-nest is globular in shape with a flat bottom attached to the substrate. The fresh foam is pure white, becoming dirty white or brown on the outer surface with age. The foam-nest measures 65 to 92 mm in diameter. The eggs are pure white and scattered in the foam nest singly and some are exposed on the surface of the mass. The eggs measure *c* 1.25 to 1.5 mm in diameter.

Tadpoles have been collected from rainfed pools, cisterns and ponds. Total length of tadpoles in hind limb stage average 50 mm. Dental formula 1:3+3/3. Beak is moderately black. According to Mohanty-Hejmadi & Dutta (1988)[14], the tadpoles take 55 days for completing the metamorphosis. The tadpoles mainly feed on Desmids, (*Scenedesmus, Closterium, &Cosmarium*), *Diatoms and filamentous algae* (*Oedogonium, Oscillatoria & Scytonema*) etc. (Sekar 1986)[15].

**Habits:** A typical tree frog of moist deciduous forest, which has become semi-urban especially in cities with extensive gardens. Enters houses where it finds the atmosphere of bath rooms congenial. In the suburbs of Madras it has been known to occur in numbers, and bears the common English name of Chunam (= slaked lime used for whitewash) frog from the pale general colouration. The Tamil name is *Therai* and it is believed that if it lands on a child the legs and hips of the child will become as slender and presumably weak as that of the frogs. Though able to swim well they never live in water and are in fact very uncomfortable when forced to remain in this element. When resting all four legs are drawn up well under the body.

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[14] MOHANTY-HEJMADI, P. & DUTTA, S.K. (1988): Life history of the common Indian tree frog, *Polypedates maculatus* (Gray, 1834) Anura: Rhacophoridae) with nine text-figures). *J. Bombay nat. Hist. Soc. 85:* 512-517.

[15] SEKAR, A.G. (1986): Ecology of amphibia of Sanjay Gandhi National Park, Borivli, Bombay with special reference to breeding behaviour of adults and food habits of tadpoles. M.Sc. Thesis submitted to University of Bombay.

### Genus *Rhacophorus Kuhl and Van Hasselt, 1822*

The generic characters are: small to very large rhacophorid frogs (30–100 mm in snout-vent length) with usually rounded snout; body usually slender with narrow waist; skin of head never co-ossified to skull; dermal ornamentations such as flaps on forearm, tarsus,heel, or above anus usually present in most species; digital pad with complete circum-marginal groove. In most species fingers and toes fully webbed. Vomerine teeth usually present. Terminal phalanges Y shaped.

KEY TO THE SPECIES OF THE GENUS *Rhacophorus*

1. Fingers more than half webbed ..............................................2
1. Fingers less than half webbed (Fig 6b)................ *pleurostictus*
2. Upper surfaces finely granulated; green above........*malabricus*
2. Upper surfaces with small warts; light reddish brown above........................................................................*calcadensis*

### **Rhacophorus pleurostictus** (Gunther, 1864)

**Diagnosis:** Medium sized frog. Adult male in the *BNHS* collection measured 49 mm SV; Female 58 SV. Vomerine teeth present in twosmall groups; snout rounded; canthus rostralis distinct; loreal region concave; interorbital space as broad as the upper eyelid or a little broader. Tympanum 1/2 the diameter of the eye. Fingers with a very distinct web at the base. First finger less than the second; toes almost fully webbed; tips of fingers and toes dilated into discs with prominent circum-marginal groove; disk of the third finger 1/2 or <1/2 the diameter of eye. Subarticular tubercles moderate. Inner metatarsal tubercle prominent. Tibio-tarsal articulation reaches the eye. Heels overlap when the legs are folded at right angles to the body.

Skin smooth or finely granular; belly and lower surface of thighs granular; a strong fold from the eye to the shoulder.

**Colour:** Greenish above with large blotches with dark edge; groin and sides of thighs purplish brown with yellowish spots or marbling; limbs with dark cross bands.
**Distribution:** Nilgiris and Anaimalai Hills.
**Breeding & Habits:** Unknown.

### **Rhacophorus malabaricus** Jerdon, 1870.
### Malabar Gliding Frog.

**Diagnosis:** Adult male measured 67 mm; female 78.5 mm in BNHS collection. Vomerine teeth in two straight series snout subacuminate; canthus rostralis obtuse; loreal region concave; nostril nearer the end of the snout than the eye; inter orbital width broader than the upper eyelid; tympanum 2/3 the diameter of the eye. Fingers and toes webbed to the discs which is equal the tympanum. Subarticular tubercles well developed. Tibio-tarsal articulation reaches the eye or nostril. Heels overlap when the legs are folded at right angle to the body.

Skin finely granular above; more coarsely beneath; granules under the thighs intermixed with larger ones; outer border of forearm and tarsus with a dermal fold; heel with a triangular dermal process.
**Colour:** Green above; often spekcled all over with black and white. Lower parts whitish, web between fingers and toes reddish.
**Distribution:** In Western Ghats from Ponmudi Hills, Kerala to Goa.
**Breeding:** Breeding coincide with the SW monsoon. A large group of frogs were observed calling in Goa forests all sitting on bamboo shoots. The call can be syllabilised as ‘tak-tak-tarrik’. The amplexus was axillary. The male holding the female at her armpit. Foamnests were attached to vegetation some metres above the pool. Tadpoles olive brown in colour closely dotted with dark-brown on the body and lighter on the tail; Length of body 16 mm, length of tail 26 mm. Dental formula is 2: 4 + 4/1 + 1:2. The toes are nearly entirely webbed The tadpoles are carnivorous. (Ferguson 1904)[16].

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[16] Ferguson, H.S. (1904): A list of Travancore Batrachians. *J. Bombay nat. Hist. Soc. 15:* 499-509.

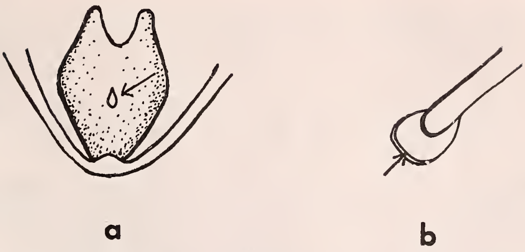

Fig. 1.
a. Tongue with papilla; b. Disc with circum–marginal groove.

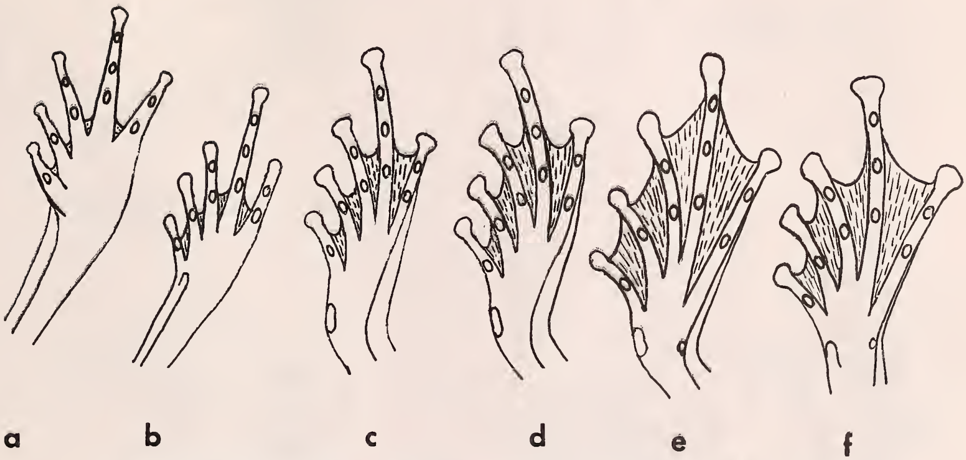

Fig. 2. Degree of toe webbing. a. Rudimentary or <1/4; b. 1/4; c. 1/2; d. 2/3; e. full; f. 3/4.

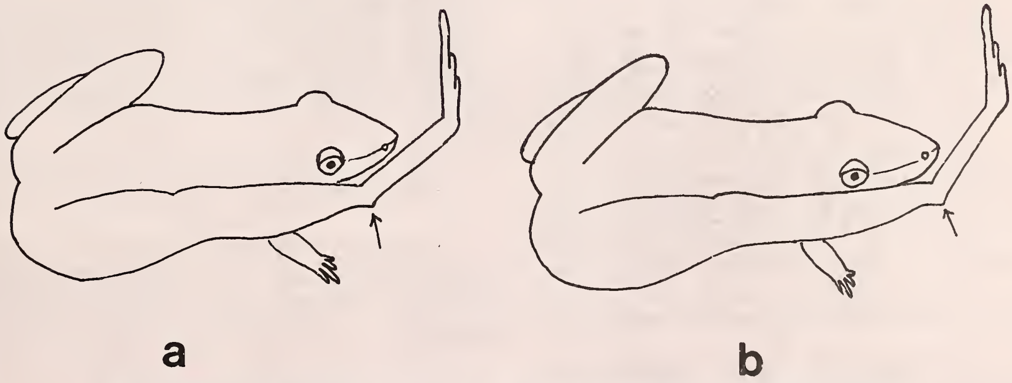

Fig. 3. Tibio–tarsal articulation: a. reaching between eye and nostril; b. reaching tip of snout.

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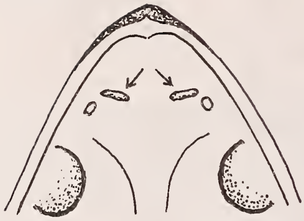

Fig. 4. Vomerine teeth.

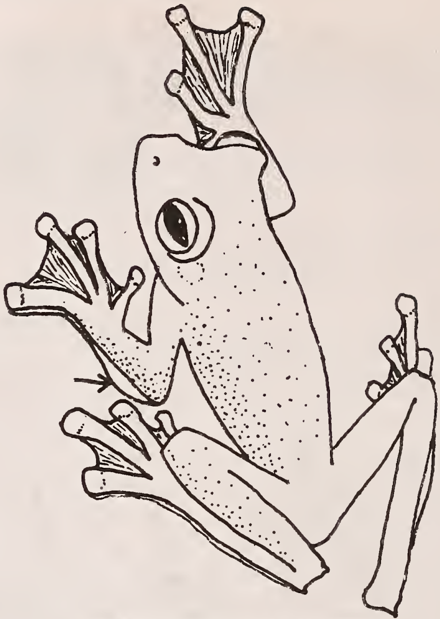

Fig. 5. Dermal fold along forearm of *Rhacophorous malabaricus*.

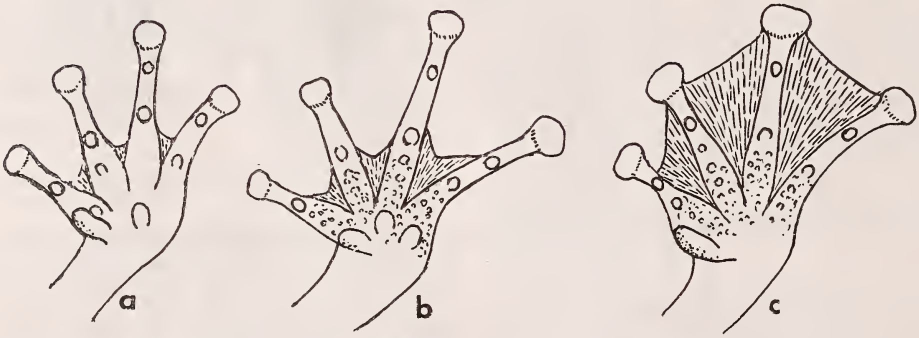

Fig. 6. Hand of: a. *Polypedates maculatus*; b. *Rhacophorus pleurostrictus*; c. *Rhacophorus malabaricus*.

**Habits:** The Malabar Gliding Frogs, occur in evergreen and moist deciduous forests of the Western Ghats. They can glide slantingly from a tree over a distance of 10 m. When jumping/gliding the webs of all four limbs are fully extended. According to Nayar (1931)[17] the frogs naturally likes humid surrounding but does not tolerate water. In captivity during the day the frogs usually rested on the leaves with their legs gathered together and body flattened with the fore-feet folded underneath their body and pupils contracted to tiny slits. This posture and their leaf green colour rendered them almost invisible among the leaves. The frogs fed on house flies at night in captivity (Abdulali & Sekar 1988)[18].

### Rhacophorus calcadensis Ahl, 1927

A medium sized frog measured 50 mm in snout to vent length; Occurs in Kalakaddu forest, Tirunelveli Dist., Tamil Nadu. Not available in the *BNHS* collection.

*(to be continued)*

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[17] Nayar, K.K. (1931): A 'Flying frog' (with a plate). *ibid 35*: 220-225.

[18] Abdulali, H. & Sekar, A.G. (1988): On a small collection of amphibians from Goa *ibid.85:* 202-205.

# APPLICATION OF SCANNING ELECTRON MICROSCOPY IN THE TAXONOMY OF CLADOCERA[1]

K. VENKATARAMAN[2] AND S. KRISHNASWAMY[3]

(*With eight plates containing forty-nine figures*)

Taxonomic diagnostic characters of the freshwater Cladocera were examined using Scanning Electron Microscope. The species are characterised by external markings on the surface of the carapace, presence of spines on the posteroventral corner of the shell, the number and arrangement of spines on the postabdomen, number of pores on the head shield, ornamentation in the ephippial eggs etc. The application of SEM to the taxonomic studies of the freshwater Cladocera provides diagnostic capabilities not available with a light microscope. It is desirable to develop a key, coupled with a reference atlas of Scanning Electron Micrographs, illustrating diagnostic characters of freshwater Cladocera species.

## INTRODUCTION

In taxonomic studies of the freshwater Cladocera, morphological criteria have, in most instances, provided the bulk of descriptive material used in classification. Surprisingly, Scanning Electron Microsocopy (SEM) has been utilised in only a few instances in examination of diagnostic characters of freshwater Cladocera (Amoros 1980, Dumont 1981a, Dumont *et al.* 1981b, Frey 1982), although it has been utilised extensively to study other aspects of Cladocera biology (Guldner 1969, Dumont & Van de Velde 1976, Schultz & Kennedy 1976, Schlecht 1977, Schlecht 1979, Seiman & Larsen 1979, Zahid 1981, Crittenden 1981). The present study presents a Scanning Electron Microscopic study of the freshwater Cladocera from southern Tamil Nadu.

## MATERIAL AND METHODS

Plankton nets with 36 cm diameter and mesh size 90 m were used to collect the different species of Cladocera. The net was dragged through vegetation and close to the bottom of shallow waters in marshes. Oblique hauls were taken to obtain Cladocera from the shores of man-made reservoirs and ponds. The samples collected from the field were preserved in 5% and 10% formalin with sugar or in 95% glycerine alcohol. The preserved samples were isolated and cleaned. The dust-free samples were dehydrated with acetone and then air-dried. The specimens were coated with silver in a Hitachi vaccuum coater HUS 5 GB. The important diagnostic features were photographed using Scanning Electron Microscope, Hitachi S 450.

## OBSERVATION

The character that differentiates *Pseudosida bidentata* and *P. szalayi* is a spine-like projection on the distal margin of the postabdomen. Fig. 1 provides this diagnostic morphological character not available with the light microscope.

Figs. 2 - 6 show the morphology of sexual eggs of *Daphnia projecta*, *Simocephalus vetulus elizabethae* and *Simocephalus acutirostratus*. Under high magnification (Figs. 4 and 6; 1500 x) the sexual eggs (*ephippia*) of *S. vetulus elizabethae* and *S. acutirostratus* show variation in their morphology. But these eggs under the light microscope appeared same except for the size.

Figs. 7 and 8 show the morphology of *Ceriodaphnia cornuta*. The honeycomb-like appearance of the surface of *C. cornuta* is a very important morphological character to identify this species.

Fig. 9 shows the hexagonal markings on the surface of sexual egg of *Moina micrura* which differentiates this species from *M. weismanni*, which consists of raised knobs. Likewise, the number of hooks on the tip of the male antennule is one of the diagnostic features to differentiate *M. micrura* from *M. weismanni*. Fig. 10 shows the presence of 4 well developed hooks in the antennule of *M. weismanni*.

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But in the case of *M. micrura*, there are three.

SEM Figs. 11 and 12 show the postabdomen and the pectens in the claw of *Ilyocryptus spinifer.* The number and arrangement of lateral denticles are clearly seen in the micrograph.

SEM Figs. 13 and 14 show the morphology of a chydorid cladoceran *Dadaya macrops*. The ornamentation on the surface of the shell of this species is unique and the SEM picture provides a clear morphology which is not available with the light microscope. Likewise, the pitted appearance in the shell of *Chydorus parvus* and fine granular structure of the shell of *Ch. ventricosus* and its postabdomen are clearly seen in the micrographs 15 – 18. The presence of posteroventral corner spine is a characteristic feature of a few species of chydoeid cladocesan. This important diagnostic feature can be seen in the species *Ch. barroisi*, which is not terminal; in *Dunhevedia crassa*, however, the spine is terminal (Figs. 20 and 22). The surface of the shell of *Pseudochydorus globossus* has hexagonal markings which are clear in SEM (Fig. 24). SEM Figs. 25 – 29 show the characteristic features of *Alona monacantha tridentata*. The presence of three connected head pores is one of the characteristic features of this species and is an important systematic tool to classify whether it belongs to the subfamily Chydorinae, which has two main pores plus two small pores in the head shield, or to the subfamily Aloninae, which has three main pores as in the case of *Amonacantha tridentata.* SEM Figs. 30 and 31 show the shell morphology of *A. davidi* and its postabdomen. The lateral groups of denticles and the claw pectens are clearly seen in SEM Fig. 31. *Grabtolebris testudinaria* is one of the rare littoral chydorid cladocera present in the marshes of tropical regions. The SEM picture provides a specific ornamentation confined to this species only. The ornamentation appears to resemble a brick wall. The presence of three posteroventral corner spines is clearly shown in Fig. 34. Figs. 36 and 37 show the ornamentation on the head shield and head pore. *Leydigia ciliata* is a littoral chydorid cladoceran present in reddish-brown turbid ponds of southern Tamil Nadu. Figs. 38– 43 show the morphology of the shell, postabdomen, pectens on the claw, shell surface of the male, male postabdomen with vas-deferens and the ornamentation on the sexual egg. The presence of pectens on the claw is a diagnostic feature which differentiates this species from *L. acanthocercoides*, which has no pectens on the claw (Smirnov 1971). *Biapertura karura*, a common chydorid present in the marshes of tropical regions, has three spines on the posteroventral corner and the ornamentation on the shell (Figs. 44– 46) are important morphological criteria which differentiate this species from *B. verrucosa*, another species co-occurring with *B. karura*. *Euryalona orientalis* is found throughout the tropical region and has a sinuation in the ventral margin and the ornamentation on the surface of the shell is an important character to differentiate this species from others. The size, number and arrangement of pectens on the claw of this species is also unique (Figs. 47– 49).

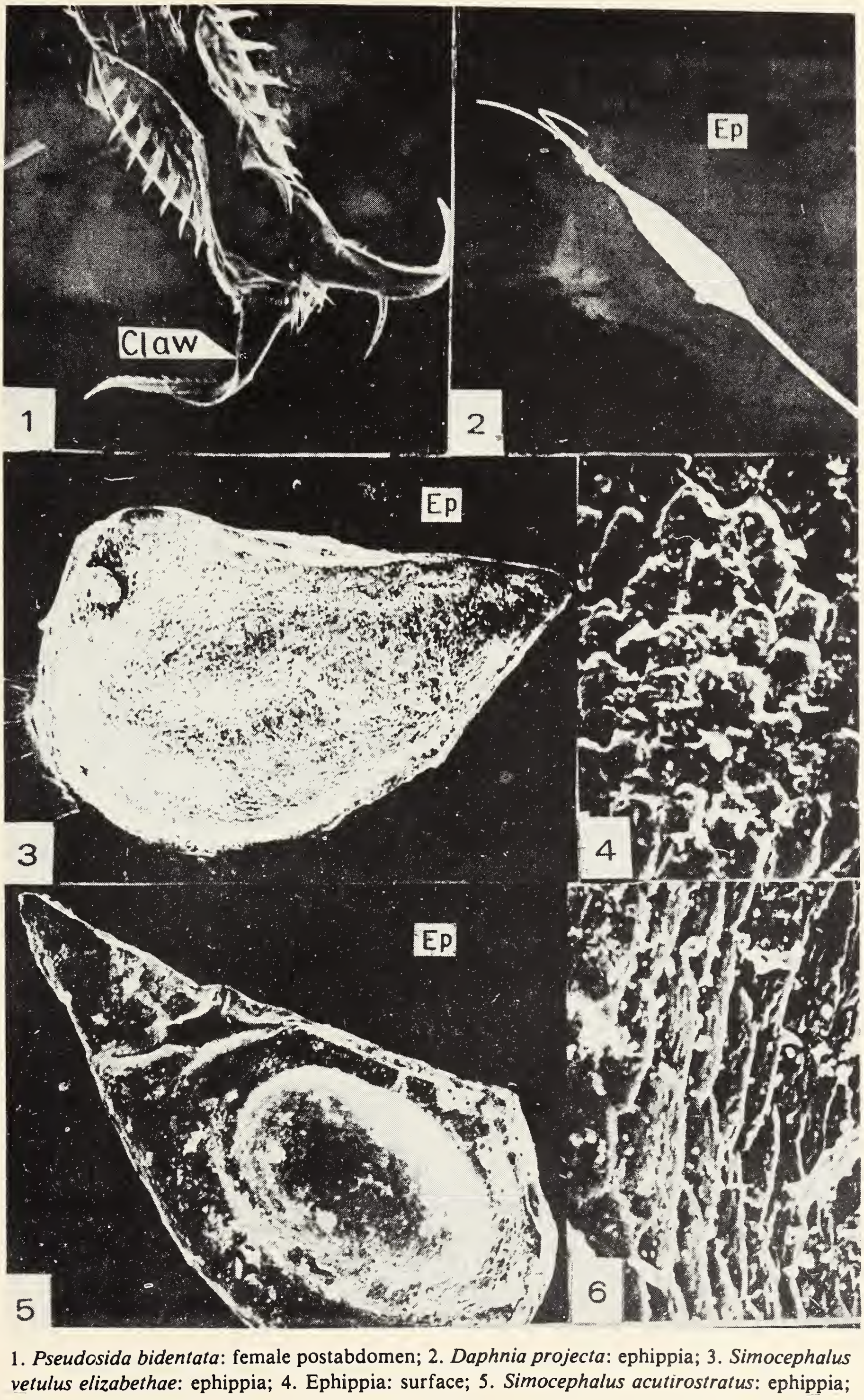
## DISCUSSION

The distinguishing features of the species of Cladocera are external markings on the surface of carapace, presence of spines on the postero-ventral corner of the shell, the number and arrangement of spines on the postabdomen, number of pores on the head shield, ornamentation in the ephippial eggs etc. It is apparent that the application of SEM to taxonomic studies of freshwater Cladocera can provide a valuable tool to the investigator, particularly if micrographs of diagnostic criteria could be gathered into a reference atlas. While morphological criteria should not be relied upon to the exclusion of other methods used in systematics (particularly in a group noted for ecomorphic variation), the SEM provides a diagnostic advantage not available with the light microscope.

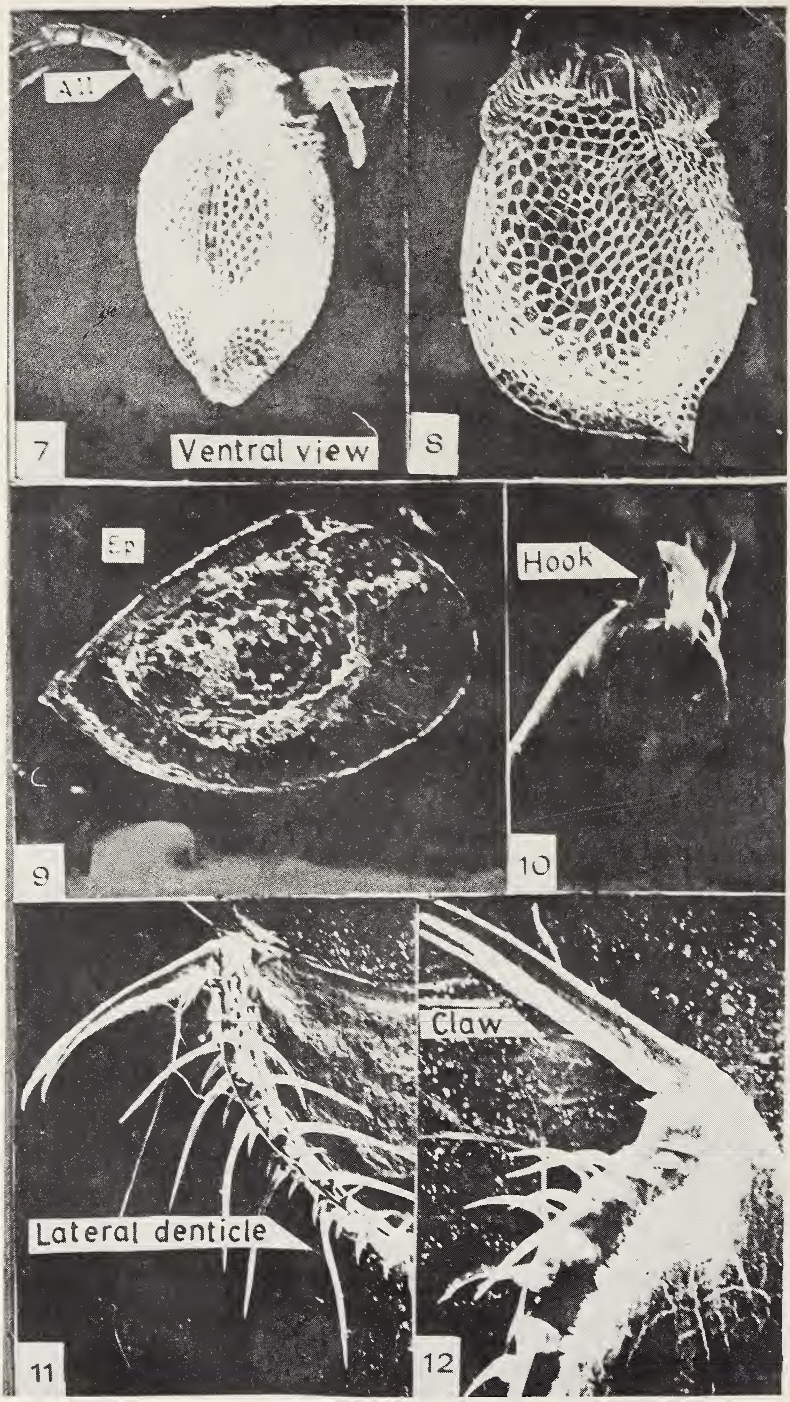
## ACKNOWLEDGEMENTS

We are deeply indebted to Dr. G. Kulaindaivelu, Department of Plant Physiology, for his help in taking Scanning Electron Micrographs. The award of SRF from CSIR New Delhi to one of us (K.V.) is acknowledged.

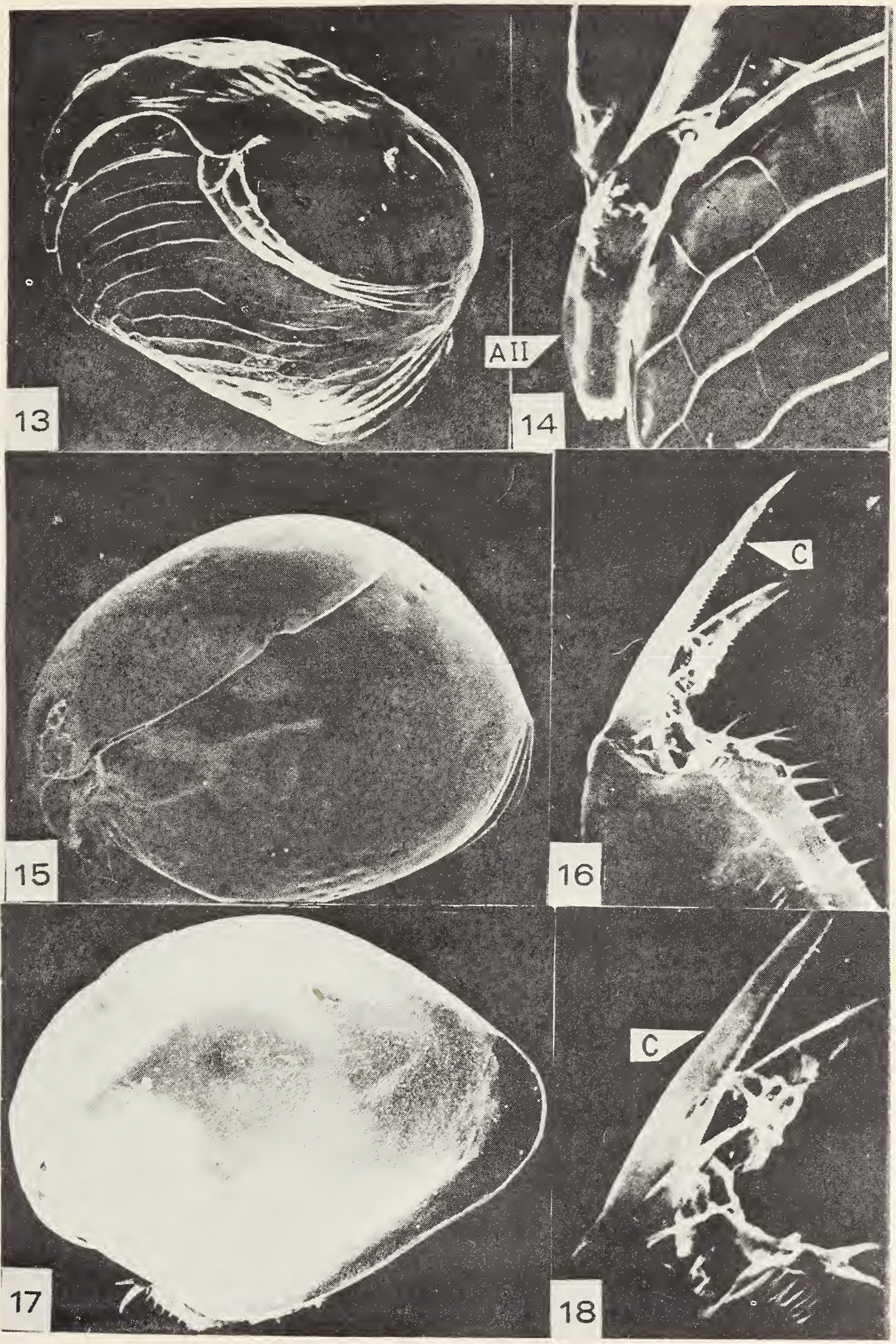
Venkataraman & Krishnaswamy: Scanning Electron Microscopy



1. *Pseudosida bidentata*: female postabdomen; 2. *Daphnia projecta*: ephippia; 3. *Simocephalus vetulus elizabethae*: ephippia; 4. Ephippia: surface; 5. *Simocephalus acutirostratus*: ephippia; 6. Ephippia: surface.

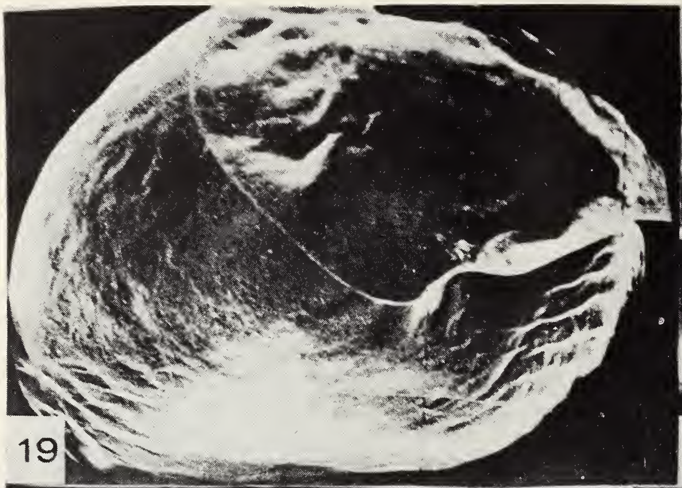

AII
7
Ventral view
8
Ep
9
Hook
10
Lateral denticle
11
Claw
12

7. *Ceriodaphnia cornuta*: female ventral view; 8. Female lateral view; 9. *Moina micrura*: ephippia; 10. *Moina weismanni*: male antennule; 11. *Ilyocryptus spinifer*: female postabdomen; 12. Female: postabdomen enlarged.



13. *Dadaya macrops*: female lateral view; 14. Female: antennule; 15. *Chydorus parvus*: female lateral view; 16. *Chydorus ventricosus*: female postabdomen; 17. Female: lateral view; 18. Female claw.

Venkataraman & Krishnaswamy: Scanning Electron Microscopy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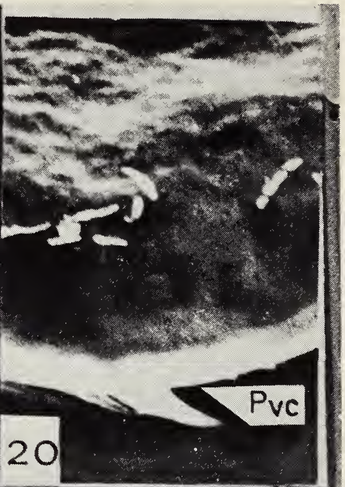
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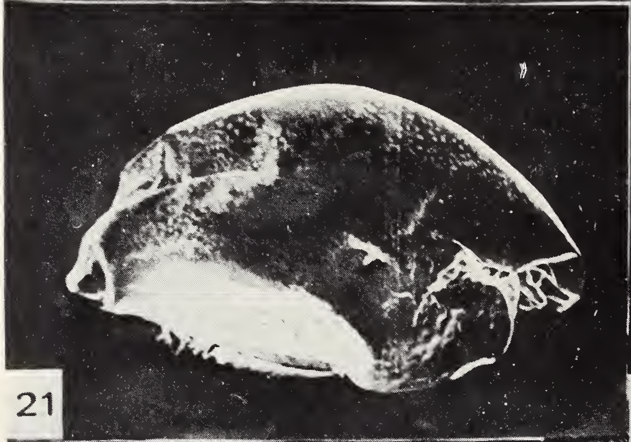
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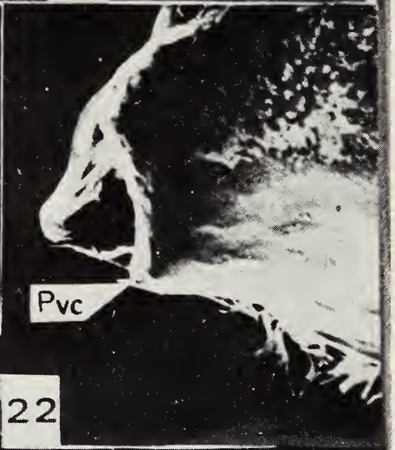
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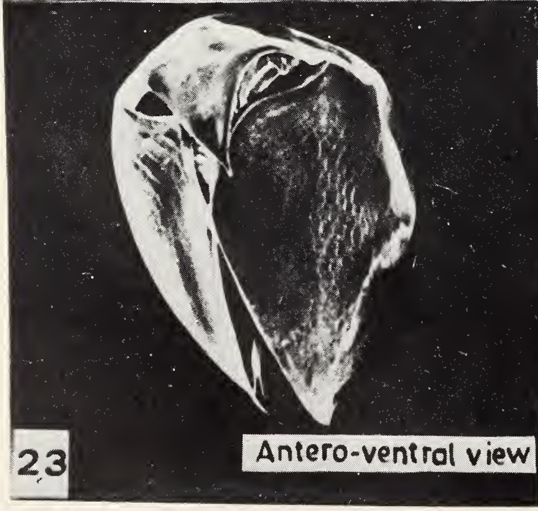
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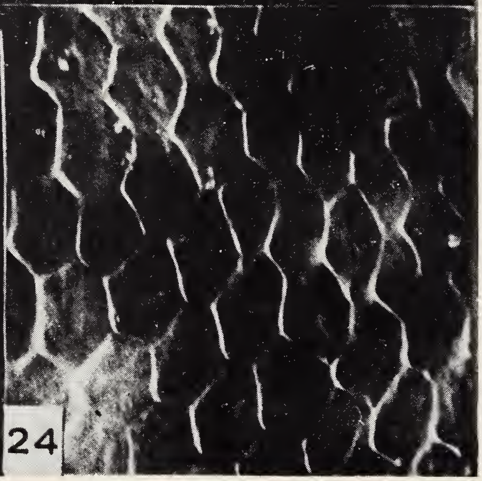
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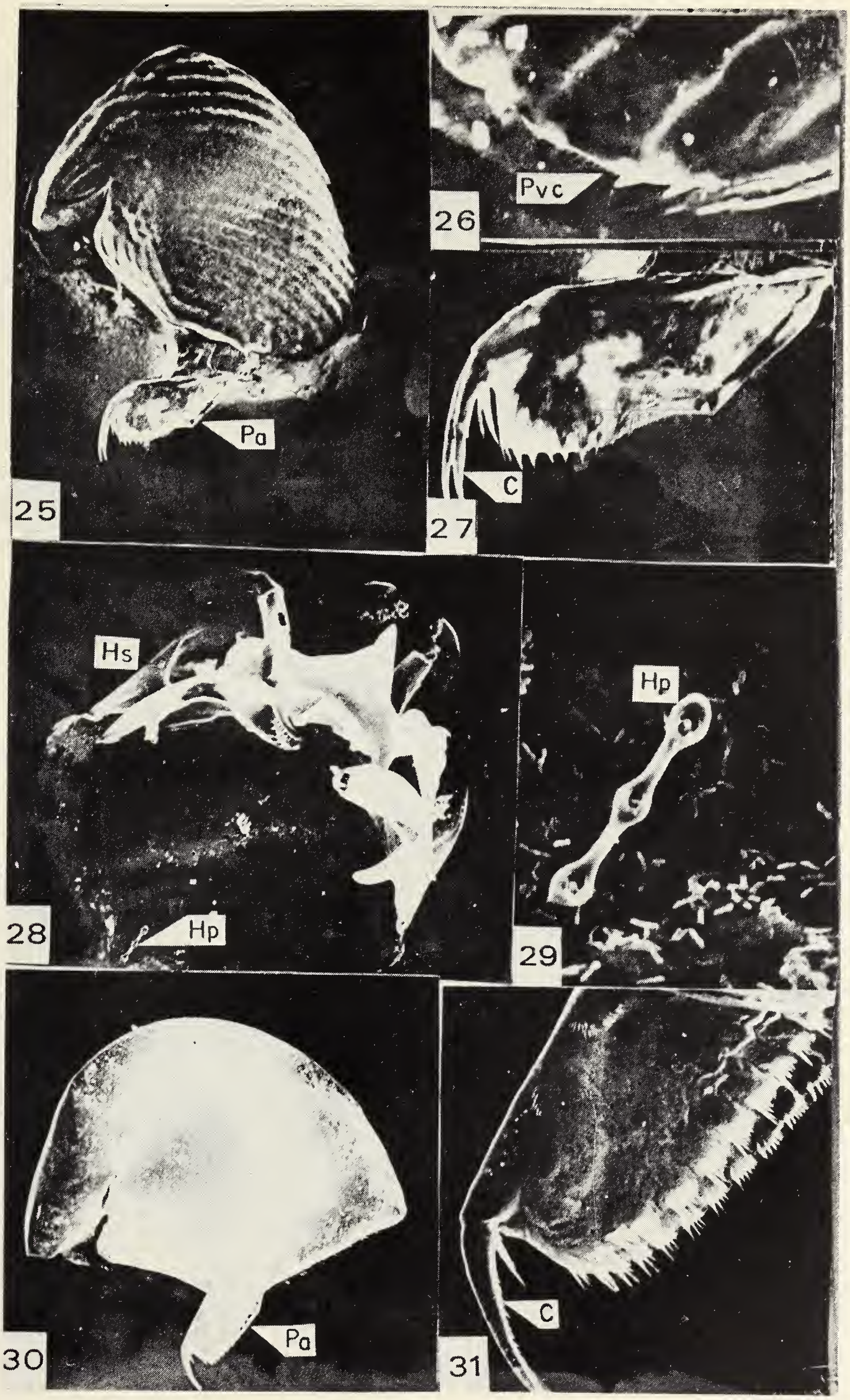
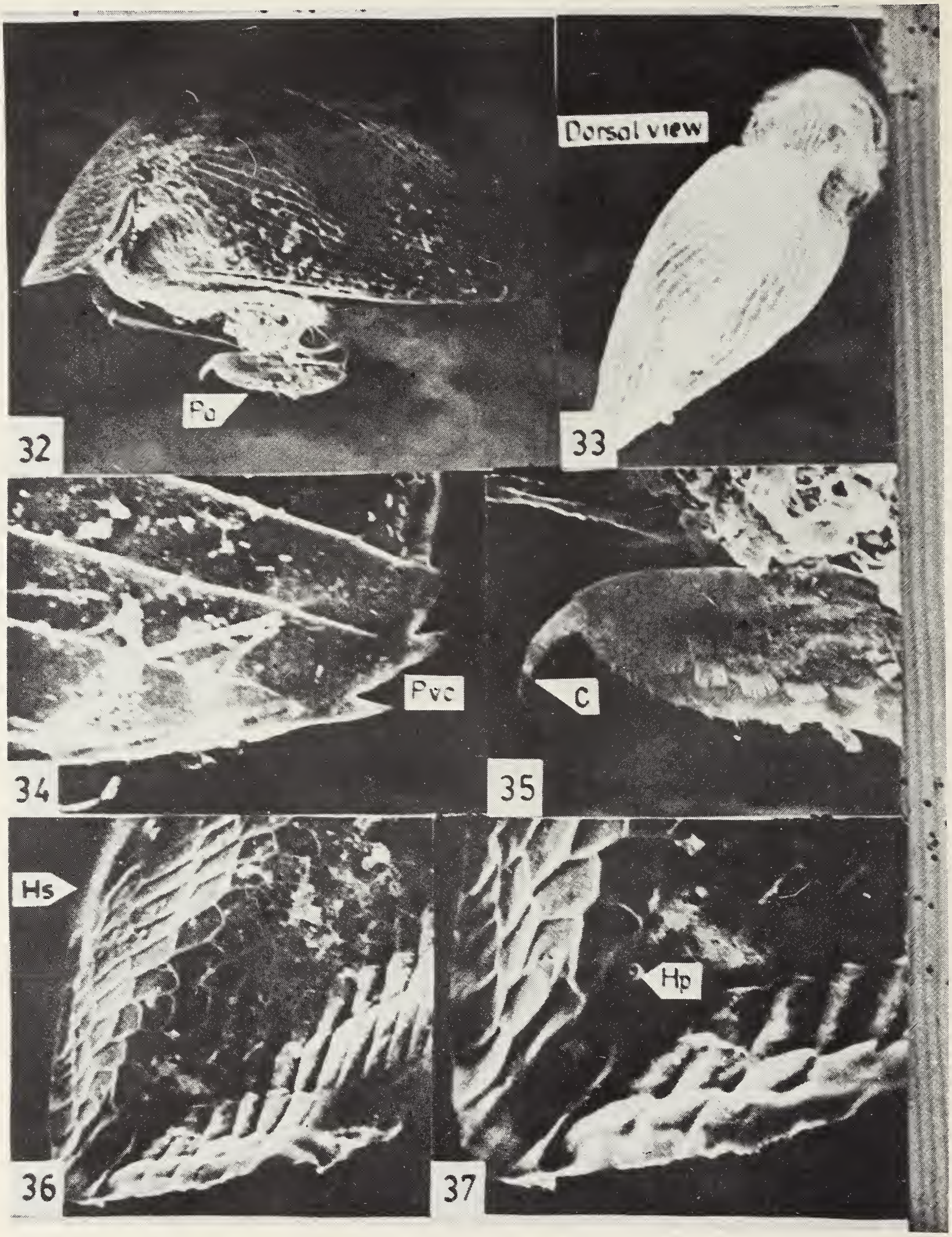
19. *Chydorus* sp.: female lateral view; 20. Posteroventral corner; 21. *Dunhevedia crassa*: female lateral view; 22. Posteroventral corner; 23. *Pseudochydorus globossus*: female ventral view; 24. Lateral surface of carapace.

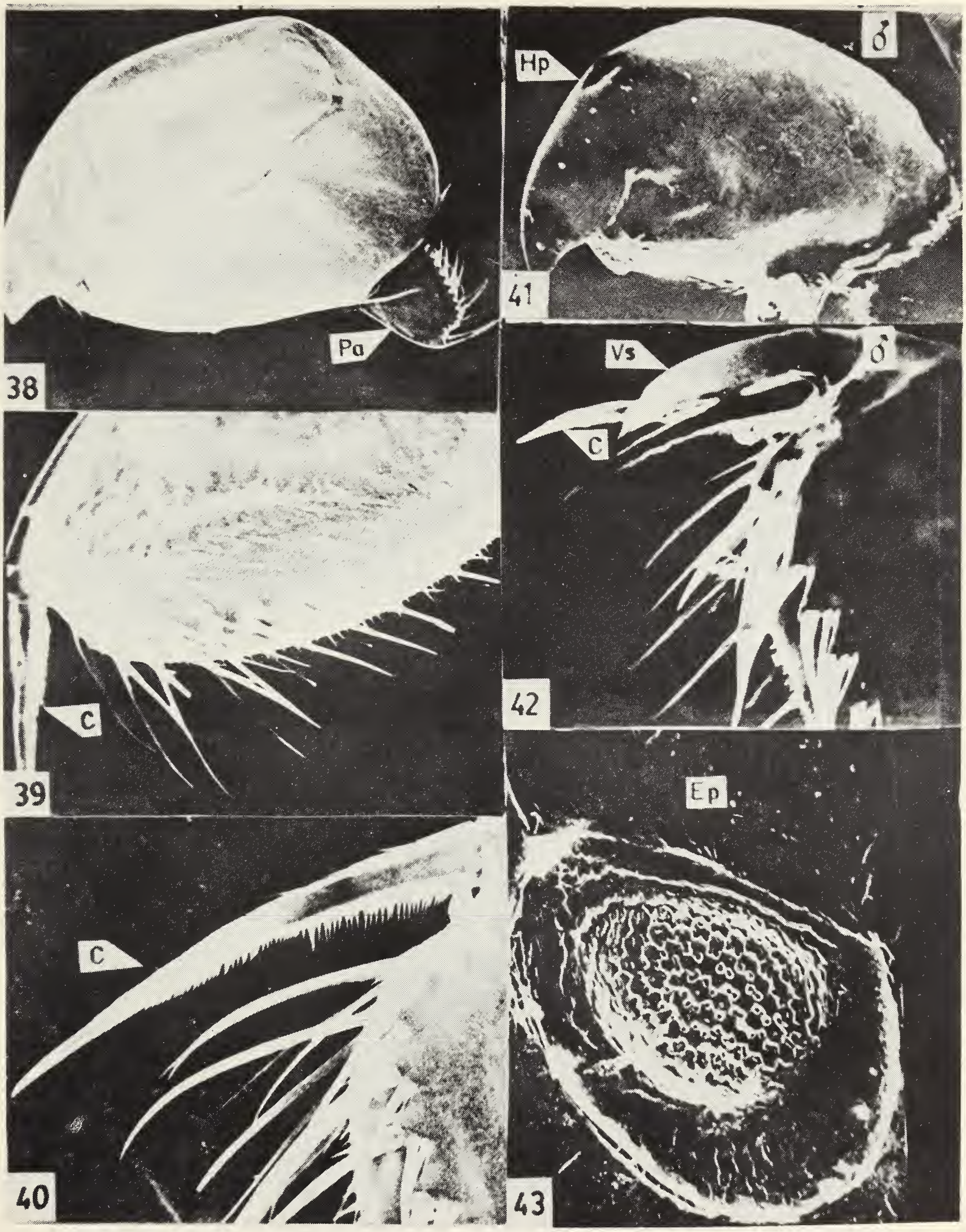
Venkataraman & Krishnaswamy: Scanning Electron Microscopy


25
Pa
26
Pvc
27
C
28
Hs
Hp
29
Hp
30
Pa
31
C

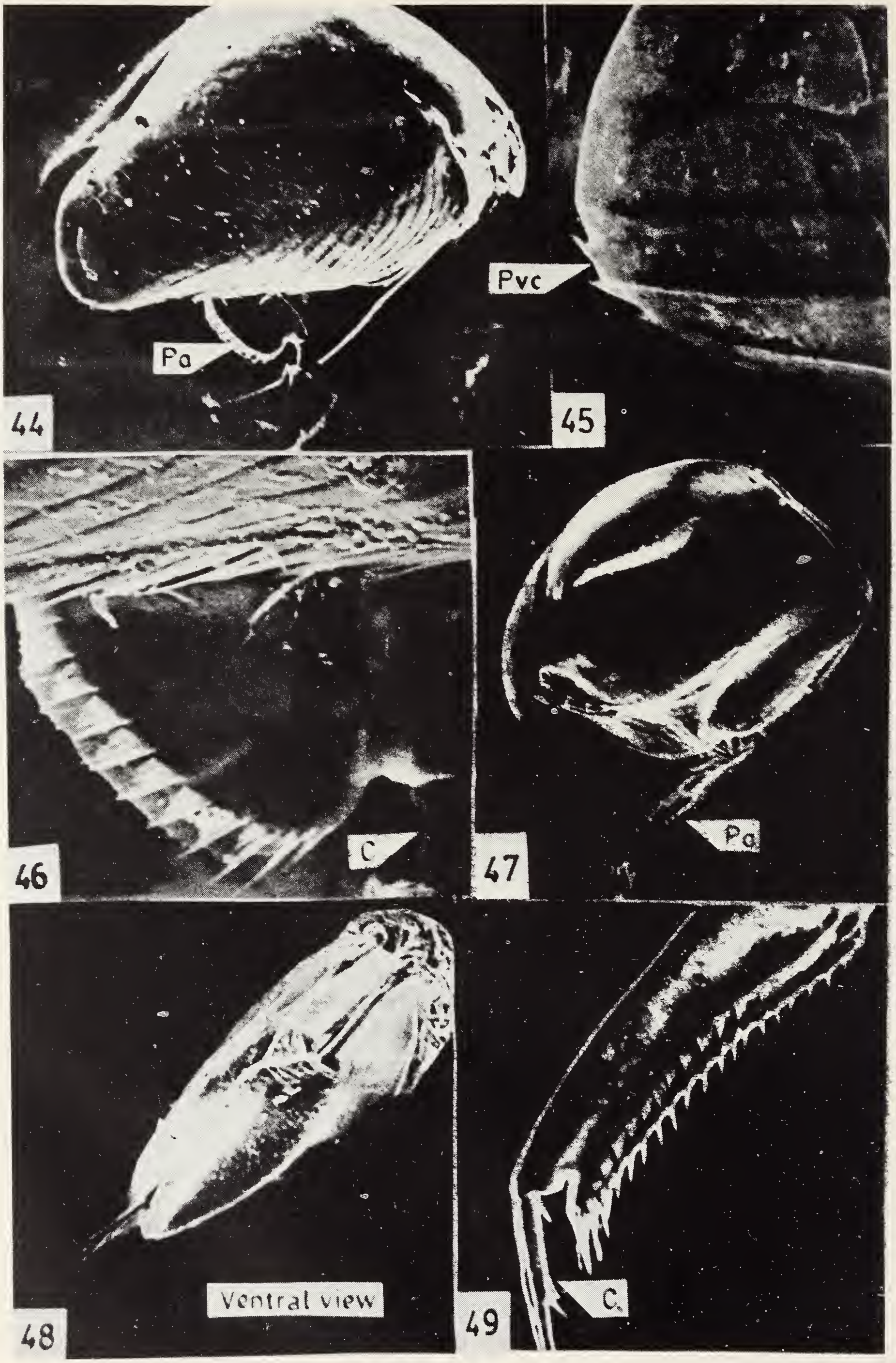
25. *Alona monacantha tridentata*: female lateral view; 26. Posteroventral corner spines; 27. Postabdomen; 28. Head shield; 29. Head pore; 30. *Alona davidi*: female lateral view; 31. Postabdomen.


Dorsal view
Pa
32
33
Pvc
C
34
35
Hs
Hp
36
37

32. *Grabtoleberis testudinaria*: female lateral view; 33. Female dorsal view; 34. Posteroventral corner spines; 35. Postabdomen; 36. Head shield; 37. Head pore


Hp
♂
Pa
41
38
Vs
♂
C
C
42
39
Ep
C
40
43

38. *Leydigia ciliata*: female lateral view; 39. Female postabdomen; 40. Female claw; 41. Male lateral view; 42. Male postabdomen; 43. Ephippia.


Pa
Pvc
44
45
C
46
47
Pa
48
Ventral view
49
C

44. *Biapertura karua*: female lateral view; 45. Posteroventral corner; 46. Postabdomen; 47. *Eurualona orientalis*: female lateral view; 48. Ventral view; 49. Postabdomen.

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# IN DEFENCE OF THE MUCH-MALIGNED (ALPHA) TAXONOMY IN INDIA[1]

A.N. HENRY AND P. DANIEL[2]

The origins of botany are in medicine (Schultes 1972). In fact they were inseparable for much of man's history. Medicinal gardens, (gardens of simples, apothecaries' gardens, physic gardens etc.), forerunners of today's botanic gardens, were established in Europe in the middle of the sixteenth century for providing living specimens for the instruction of medical students and the supply of actual drugs for medicine. A herbarium, which in the modern sense is 'a great filing system of information about plants, both primary in the form of actual specimens of the plants and secondary in the form of published information, pictures and recorded notes', became an indispensable adjunct of such a medicinal garden in due course.

With the unprecedented spurt in travelling and voyages of discoveries, and the consequent vying for empire-building in the seventeenth and eighteenth centuries the holdings in such gardens increased exponentially, and so did those in their herbaria. The ever increasing holdings made these gardens play the vital role of introduction, cultivation and distribution of both native and alien crops of potential value and promise. Such botanic gardens established by the colonial powers in their tropical colonies in the eighteenth and nineteenth centuries too faithfully undertook such responsibilities. Botanists/taxonomists who manned these gardens were instrumental in the introduction of a host of commercial crops including coffee, jute, rubber and tea, and a number of medicinal plants including *Cinchona.* And from their herbaria came a treasure of information in the form of floras and other publications by taxonomists (naturalists) who manned them.

The scenario narrated was no different in the Indian context. The *Flora of British India* was published at the end of the last century. This gave the impetus for the publication of some of the regional floras. There is a feeling in certain quarters that these publications marked the end of herbarium taxonomy or alpha taxonomy, more appropriately called practical taxonomy, in India. That this feeling is unwarranted is discussed elsewhere in this paper. Taxonomic research in India was in the doldrums after the publication of the afore-mentioned floras. It was the reorganization of the Botanical Survey of India in 1954 which gave a fillip to this research.

Botany was synonymous with taxonomy till the turn of this century. The scenario began to change soon, with more branches of botany emerging from the increased knowledge of botany through taxonomy. Constance (1964) opined that organisms are viewed merely as relatively uninteresting containers within which interesting physico-chemical processes are taking place, and only the latter are worthy of serious study. In short, this trend toward 'reductionalism' has gone to such ridiculous extremes that we are probably about to witness the swing of the pendulum of interest in some other and as yet unperceived direction. This swing of the pendulum visualised by Constance has already taken its toll in the developed countries. With the feverish attempts of Indian botanists, aping the West and seeking pre-eminence for their chosen more modern disciplines with more sophisticated gadgets, alpha taxonomy, the once glorious and fundamental discipline of botany, has been pushed aside from the mainstream in this country. Some of those who believe that the days of alpha taxonomy are over, and falsely so, have been advocating accent on biosystematics.

Is alpha taxonomy irrelevant? Is the upstaging of alpha taxonomy by biosystematics justified in the current Indian situation? Two simple facts, *viz*., that larger dicot genera such as *Astragalus, Cousinia, Ranunculus, Senecio* and *Solanum* have never been monographed since De Candolle's *Prodromus* (1824-1874) and the current frenetic flora writing activity in the Neotropics would negate such a proposition. The well- considered observation of Parker (1978) that taxonomists are still far behind with the production of the descriptive and classificatory work, and also with the distributional studies that are necessary both to provide a basis for phytochemical and agronomic surveys and to gain a

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sufficient knowledge of disappearing wild species so that theories appertaining to their phylogenetic relationships may be developed, might further highlight the importance of the role of alpha taxonomy today, particularly in a developing, tropical country like ours. Perhaps in some of the western countries whose not-all-that-rich temperate flora is well-known the supersedure of alpha taxonomy by biosystematics might be justified, but not in India.

Taxonomy is the practical result of the basic human urge and necessity to make some kind of comprehensive arrangement of the elements of the environment. Man's desire to classify lies at the root of the acquisition and care of systematic collections. Afflicted with ataxophobia, to quote Smith (1966), the taxonomist takes upon himself the arduous task of putting some order in the tangle of the plant world. One of the main purposes of taxonomy is the 'intricate, unspectacular, slowly proceeding, meticulous business' (Jacobs 1974) of piecing together scattered bits of information derived from the field, herbarium and literature into a highly formulated schematic set of publications in the form of floras, revisions, monographs, keys, handbooks etc. which provide a means of identification, naming and communication about plants for use by other taxonomists and, more importantly, for non-taxonomists of all sorts. Without such a system of classification and nomenclature many other biological and non-biological activities would be severely hindered.

The service most required from taxonomists/systematists by the general public is the provision of the correct names for species. When an alien species is noticed in one corner of the country and spreads fast to other areas, soon causing public concern as in the case of *Parthenium hysterophorus*, it is the alpha taxonomist who is approached first for its identity and nomenclature and not the biosystematist. Ecologists, experts on eradication and those who try to find alternative uses and others of that genre step into the scene only thereafter. This basic service of providing correct identification is needed most by research workers in other disciplines of botany/biology who more often than not have a supercilious attitude towards the alpha taxonomist. It seems necessary to point out that research work on plants, no matter how brilliant, painstaking and accurate, is utterly worthless unless the identity of the plant is fixed. It is not unknown for a chromosome count to be published for a plant whose identity has no greater validity than the name on a seed packet and is not even substantiated by a voucher specimen (Bor 1964).

In fact such a count would amount to only a ghost count as it is not verifiable should another worker doubt its authenticity at a later date. Even in ecological studies it is absolutely necessary to get the identity of the plants established and voucher specimens deposited in an established herbarium, failing which such studies will not be of much use. Moore (1978) points out that during the first four decades of this century chromosomal reports were rarely related to particular voucher specimens in herbaria, so that the identity of the plants could not be verified. The situation in India does not seem to have changed much even today. It is a pity that in India many workers are either ignorant of the importance of voucher specimens or just do not bother to deposit them in a herbarium.

Biosystematists are sometimes of the opinion that alpha taxonomy is not a science worth the name as the species concept the alpha taxonomist employs is untenable. The concept of 'morphospecies' has been an object of derision for the biosystematist. To quote Constance (1964), speculation, imagination and intuition are precious attributes of the human mind and must not be proscribed. It may be pointed out that science is primarily a method rather than a set of abstract truths; that method involves not a fixed adherence to some formal, universal rules, but rather the judicious balancing of such opposites as speculation and observation, quantitative analysis and qualitative consideration. Alpha taxonomists need a practical species concept because adequate experimental evidences and even field observations are frequently lacking. Hence, they have to deal mostly with morphospecies, as has been pointed out by Davis (1978). Even when we have information on crossability it is mainly useful in tipping the balance in cases of uncertainty of treatment. It is needless to stress that such information is of no use in the field.

In short, there should be an acceptable degree of difference between closely related species. Species, as they occur in nature, are the taxonomists' building bricks to which binomials are applied for convenience, whether they are potentially inter-sterile or not (Davis 1978). We seldom know how constantly exomorphic characters are correlated with cytological or genetic ones — in many cases an assumed correlation breaks down when more material is examined. In dealing with the flora of the tropics, however, we seldom have any direct evidence of internal breeding barriers. For the majority of plants, binomials must be applied to representative populations that can be morphologically distinguished from one another, allowing perhaps for some degree of hybridization, especially in disturbed habitats (Davis 1978). Furthermore, it is an over-simplification to try to differentiate consistently between the phyletic and phylogenetic information derived from the chromosomes, but it is also too facile to give chromosome data an overriding importance in taxonomy. Claims that different chromosome numbers (*n*) indicate specific differences while different basic chromosome numbers (*x*) signal boundaries between genera (Love & Love 1974) cannot be uniformly justified or applied (Moore 1978).

Heywood (1963) has argued that morphological criteria alone should define species limits and has rejected any definition based on reproductive isolation, despite the fact that morphologically defined species "will represent different kinds of evolutionary situations and will be equivalent only by designation". This argument is based on the view that species must be visually recognizable to have any widespread practical application, and that in any case our information is far too incomplete to apply the cytogenetic criterion in all but a minute proportion of cases (Stace 1978). Favouring the argument of Heywood, Raven (1976) has opined that species should not be redefined in cytogenetic terms. Hence what is required in the present circumstances in a developing, tropical country like India endowed with a rich flora is good representative collections with ample and accurate field data so that we can strive for a flora that is better than that of the past with additional/new information on various aspects including the economic potential of our plants.

But then, where does taxonomy, the most relevant discipline of botany stand today in India? It is neither in its infancy nor senility. Perhaps we are yet to complete the exploratory phase. Several areas in the country particularly in the Himalayas, Eastern India and the Western Ghats still remain either under- explored or unexplored. Hence, suggesting stepping into the consolidation phase at this stage would amount to making a compromise and lead to choosing the inevitable *via media*. Over 3400 species have been added since the publication of the *Flora of British India* from the present Indian territory. After the reorganisation of the Botanical Survey upwards of 250 new species have been discovered from Peninsular India alone. These should amply testify to how far we have moved from the exploratory phase. Though a number of district floras have begun to appear lately, inventories for larger areas (excluding checklists) are not many. A modest beginning was made by the Botanical Survey in the consolidation phase by bringing out the flora of India in the form of fascicles. Its publication in the form of volumes is in the offing.

What has stymied the progress of alpha taxonomy in India and prevented it from regaining its respectable and legitimate status? A few major factors deserve special emphasis. The lack of large, representative collection has been a deterrent. Europe houses about a third of the world's herbaria (*c.* 350) and more than half of the collections in terms of number of specimens (90,000,000). Yet the flora of Europe is some 12–13000 species (Heywood 1980). In India, whose flora is estimated to have 14–15000 species, we have less than two dozen recognised herbaria with less than 2,000,000 specimens. Very few herbaria like CAL, DD and MH have specimens in lakhs. Many herbaria of recent origin in universities and colleges have very small holdings (sometimes few thousands only) of almost exclusively of local collections. That herbaria have a vital role to play has been stressed by Subramanyam and Sreemadhavan (1972). It is necessary that more herbaria financed by public funds are established in the various regions of the country for local collections and the holdings in the existing ones are augmented for a better assessment of the country's flora and help resource management which is needed more than ever before in the present environmental crisis.

A plant is described from a collection, made by a collector, at a place, on a certain date. Yet no one of these four elements in fact needs to be present, and indeed, one to all of these bases have been missing now and then in the history of phytography. Dozens of species in *Species Plantarum* carry no locality or only an omnibus phrase that may hold a continent. Pursh, Nuttal and many others of their time published new species without fixing on a collector, a collection taken at an exact place, and dates were more often omitted than mentioned. Rafinesque evidently produced his *Florula ludoviciana* without benefit even of specimens (Ewan 1969). And Rafinesque perhaps was no exception. Roxburgh, the trailblazer in Indian botany, never knew that the confusion galore arising from his indifference towards/ignorance of preserving the plants on which he based his new descriptions would take generations of European and Asian botanists to undo. To establish the identity and nomenclature of all such plants described after 1753, types and protologues are absolutely essential. The non-availability of type specimens and old taxonomic literature as has been indicated by Santapau (1962) has been a stumbling block for Indian taxonomy. It has been pointed out by Prance (1977) that tropical specimens are lying in herbaria of temperate countries, for historical reasons. In a number of cases we have not been able to even trace the types. And authentic specimens are equally difficult to get. Many plants do not have representative specimens in any of the Indian herbaria.

Motivated by parochialism and jingoism (not an accusation as it appears to be a basic human instinct), explorers and naturalists of the colonial powers never cared to leave a set of their collections in the country to which they rightfully belonged (did any so-called native bother about such rights at that time, anyway?). Tracing the types becomes all the more difficult when the same botanist donated sets of his collections to different herbaria without proper annotations or maintained more than one herbarium at a time. The original set of the Royle herbarium on which he based his *Illustrations*, thought to be in the possession of Royle himself, was lost until 1952, when it was rediscovered in the City of Liverpool Museum by Stansfield. However, there are type specimens in the Royle's collections at Kew, British Museum and Dehra Dun (Lauener 1978).

In many instances plants that were described in century old books which are no longer available even for a fortune and equally old obscure and discontinued journals including nursery catalogues and other such ephemera protologues are almost impossible to get, a factor that has exacerbated the situation. Only in a couple of libraries attached to herbaria in India is there a reasonable collection of old literature. To those non-taxonomists for whom the name change effected by European taxonomists on Indian plants has always remained a riddle, the answer should be obvious. The Botanical Survey is making efforts to procure at least a set of photographs of type specimens and other authentic materials of Indian plants deposited in the Kew herbarium. This should not lead to the mistaken notion that all the type specimens of Indian plants are in Kew. They are in herbaria spread over the whole of Europe and perhaps elsewhere too. Steinberg (1977) tells us that in the holdings of the Herbarium Webb at the University of Florence, Italy, there are specimens from the collections of many pioneer collectors in India including Bentham, Falconer, Griffith, Jack, Koenig, Persoon, Rottler, Wallich and Wight to name a few. Since the aforesaid venture is a long-term process fraught with difficulties, a sudden change all that soon in this direction is unlikely.

A little digression into nomenclature seems necessary at this point. The complaints from non-taxonomists about the frequent and vexing name changes in Indian plants and their disparaging the International Code of Botanical Nomenclature, which tragically is recondite to many, are not infrequent. Name changes are brought about usually either due to change in the concept of a taxon or digging through old literature and establishing priority. We do not deny that there was a so-called muck heap of synonyms in Indian taxonomy. But it should be admitted that it has become reduced considerably of late. With numerous explorers and naturalists sending specimens from India to various destinations in Europe and most of the taxonomists of temperate countries having no knowledge of the variations in tropical plants and consequently mistaking each specimen for a distinct species a deluge of synonyms was perhaps inevitable. Lack of communication with workers spread over the whole of Europe and Asia and the belated organized efforts towards the standardization and legislation of nomenclatural practices coming to fruition only at the Ist International Botanical Congress in Paris in 1867, and the British taxonomists with their ascendancy, by virtue of the vast empire the Britishers had built, tragically refusing to cooperate with the rest could not but add much to this muddle.

As pointed out earlier, the difficult-to-get old literature, particularly obscure journals, nursery catalogues and other such ephemera and the types have fettered Indian taxonomists in their efforts to clear much of this muck heap. And infraspecific names are almost impossible to trace in many instances as there are no indices for them. However, they have been doing their best with the available, limited facilities along with those with ample facilities at their disposal in Europe. That being the crux of the matter, it is unwise to question the wisdom of the founding fathers of the Code, the objective of which is stabilization of names. Much of the confusion has been already undone by adhering strictly to the Code since 1950s. By some more striving and digging by Indian taxonomists the huge heap that once it was, is likely to become a no-heap in the near future.

The lack of adequate trained personnel in taxonomy has been a hurdle in its progress. Regrettably, this has yet to receive the effective attention of the competent authorities. There is no gainsaying the observation s of Khoshoo (1980): there is a dearth of qualified teachers in taxonomy; our teaching methods are outdated, resulting in an aversion on the part of students of taxonomic courses; the teachers themselves feel hurt if they are addressed as taxonomists, and there is a total lack of eagerness on the part of students for field botany. At least a part of this stems from the fact that taxonomy has already been pushed aside from the mainstream in the country. There is a misconceived notion among non-taxonomists that unlike other disciplines of botany, taxonomy is a discipline in which no proper training is required for research. Perhaps untrained and ill-trained persons are the cause for the accumulation of bits and pieces of specimens with no proper or misleading field notes occupying much of the precious room in herbaria and confusion in taxonomic literature.

We would like to dispel the opinion that taxonomic research is the preserve of some of the national institutes like the Botanical Survey. Were it so, it would not have apportioned funds and offered facilities to research workers in universities and colleges for about 60 District Flora Schemes in the country. It is heartening that a few centres of taxonomy have come up of late in colleges and universities particularly in Peninsular India. It is too uphill a task for an organisation like the Botanical Survey, with its limited staff, to complete the flora of India, let alone within a specified time. That is why it has sought the assistance and cooperation of academic institutions wherever possible. Again, research institutes like the Botanical Survey of India who do not have a formal academic programme cannot be expected to train taxonomists at the post-graduate level. We suggest that the universities come forward to willingly shoulder this responsibility. And the Botanical Survey of India, in which a training institute is being established with a couple of staff to begin with, can perhaps assist the universities in an in-service training. It is suggested that the lost importance of taxonomy in the syllabii in colleges and universities is restored before long. In this regard the recommendations made by the Seminar on Teaching and Research in Plant Taxonomy held in Mysore in 1979 and the syllabus devised by Subramanyam and Nayar (1973) with the necessary modifications deserves serious consideration and implementation without losing time.

The quality of research by a worker depends upon the interest and devotion he has for his chosen discipline. There is a feeling among certain taxonomists that taxonomy has been thrust upon them by circumstances and for that simple reason they have to oblige taxonomy. Hence, it is necessary to dispel such a misconceived notion while the researcher is being trained, especially at the doctoral level. Creating opportunities for the well-deserved, if not for all, to conduct research in floristic and monographic work after training becomes a corollary which would attract talent in future. And the ones with a little more acuity, perseverance and enterprise should be encouraged to take up research in much neglected aspects in the Indian context such as botanical history, involving much digging, typification of Indian plants and determining the validity of their names according to the Code, particularly in works like *Hortus Bengalensis* Catalogues of Wallich and Wight and interpretation of herbaria of the pioneer collectors in India. Letting them languish for want of better opportunities would definitely drive away talent to other disciplines.

We suggest that more career opportunities be created in national institutes now engaged in taxonomic research and that all post- graduate colleges and universities have a herbarium and a trained taxonimist to man it, who can also have teaching assignments so that his promotion is not curtailed. It is a pity that even the oldest universities like the Madras University do not have an herbarium worth the name. The vital role of trained taxonomists in some of the related establishments may be impressed upon people, so that they can find suitable placements in forestry, agriculture (particularly in exploring for wild allies of crop plants), pharmaceutical and other related industries requiring resource development. It is absolutely necessary to insist upon employing taxonomists in environmental assessment, and in the scientific management of biosphere and other such nature reserves.

As has been pointed out by Heywood (1982, 1985) there has recently been a major resurgence of floristic taxonomy, partly stemming from the recognition that such a work is an essential precursor of conservation activities and partly from the realisation of the massive scale on which plant resources such as the tropical forests in developing countries are being converted to other uses, consumed or destroyed. This has drastically foreshortened the time-scale against which taxonomists have to operate. The forest cover in the country is far less than the stipulated ideal of 33.3%. It has been estimated, a moderate estimate perhaps, that in India over 850 species of flowering plants are threatened due to habitat destruction and other interlinked factors (Jain & Sastry 1983).

The tenure of many of the plant species is precarious. As a result, taxonomists are in an unenviable position of accumulating data on the plants while it is available on priority basis. Vanishing along with the forests are the cultures of some of the tribal peoples. The interest in the cultures of these people has done much to reveal their dependence on the food and drug flora, which is closely interwoven with all the details of their daily lives. A knowledge of this flora may continue to yield data of great importance to the urban man. The future of botanic gardens and taxonomy is again linked, this time in the common goal of floristic inventory, conservation and resource studies (Heywood 1985). In the present environmental crisis taxonomists have to work more closely with ecologists, plant-breeders, conservationists, resource management personnel and environment managers. And Indian taxonomists are not unwilling to shoulder this new, additional responsibility.

"Do not try to put two arrows on the string at once - they will both miss. He that would load his gun with two charges cannot expect to be successful". The moral is more than clear. We do not intend to denigrate biosystematics — or any other discipline of botany for that matter — nor are we opposed to biosystematics. Our aim is to stress that it is ill-advised to give priority, nay equality, to biosystematics over alpha taxonomy under the present circumstances in India. Such a priority would be lopsided and tantamount to putting the cart before the horse.

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# NEW DESCRIPTIONS

## *BARILIUS NELSONI* , A NEW CYPRINID FISH (PISCES : CYPRINIDAE) FROM TRIPURA, NORTH-EASTERN INDIA[1]

R.P. BARMAN[2]

*(With a text-figure)*

A new freshwater fish of the genus *Barilius* Hamilton collected from Tripura, North-eastern India is described and illustrated under the name *Barilius nelsoni*. The new species is similar to *Barilius evezardi* Day and *Barilius radiolatus* Gunther but can be easily separated from the former by the presence of barbels and in having the dorsal fin exactly midway between the hind margin of the orbit and base of caudal fin. The new species differs from the latter species in having fewer lateral line, predorsal and circumpeduncular scales.

### INTRODUCTION

The fishes of the cyprinid genus *Barilius* Hamilton are conspicuous in the fauna of the Indian subcontinent, Thailand, China and Africa. These fishes are, for the most part, inhabitants of hill or mountain streams, although some species live in low-land waters. Usually these fishes have dark spots or bands on a silvery body. Day (1889) recorded 14 species and Jayaram (1981) enumerated 16 species under the genus *Barilius* from the Indian subcontinent. Recently, Barman (1985, 1986) discovered two new species of this genus from Arunachal pradesh (28°N, 95°E) and West Bengal (23°N, 87°E). Howes (1980) made a very valuable contribution to the anatomy, phylogeny and classification of bariliine cyprinid fishes.

During the taxonomic studies on the fishes of Tripura, nine specimens of a species were referable to this genus which, when compared with the known species of the genus *Barilius*, appeared to represent a hitherto undescribed species. The present species is being described as *Barilius nelsoni*. In the species descriptions, the mean and, in parentheses, range are given for proportions of body parts to either head length or standard length.

### **Barilius nelsoni** sp. nov.

*Material*: *Holotype* (Fig.1): 62 mm. SL. Regd. No., FF2396 Zoological Survey of India, Calcutta Locality: Gumti River, Udaypur subdivision, South Tripura district, North- eastern India. Collector : R.P. Barman and party. Date of collection : 15-8-1985.

*Paratypes*: 8 examples, 42-55 mm. SL. Regd. No. FF2397 ZSI, Calcutta. Locality, collector and date of collection same as in holotype.

### DIAGNOSIS

Dorsal fin origin exactly midway between the hind edge of the orbit and caudal base. Head length 4.54-4.76 and body depth 4.33- 4.58 in standard length. Eye diameter 3.25-3.66 in head length. Least depth of caudal peduncle 1.66-1.85 in its length. Lateral line scales 38-39, predorsal scales 14-16 and circumpeduncular scales 12-14. Barbels 2 pairs. Body with a darkish longitudinal band on its lateral sides.

### DESCRIPTION

Head length 4.65 (4.54-4.76) at the most distant point on the opercular membrane, body depth at pelvic origin 4.46 (4.33-4.58), predorsal distance 1.76 (1.73-1.78), prepelvic distance 2.18 (2.16-2.21), preanal distance 1.55 (1.52-1.57) and length of the longest ray of the caudal fin from base 4.28 (4.00-4.76) in standard length. Depth of head 1.28 (1.22-1.33) at the occiput and width of head 2.10 (2.00-2.20) in head length. Eye diameter 3.49 (3.25-3.66) in head length, 1.18 (1.12-1.33) in interorbital width. Snout length 3.75 (3.66-4.00) in head length, 1.27 (1.16- 1.33) in interorbital width. Length of the postorbital part of the head is slightly less than twice

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the length of the preorbital part of head (or snout length). Cleft of mouth wide, extending to below middle of the orbit. Upper jaw conspicuously longer than the lower jaw which is provided with a poorly developed symphysial knob. Barbels 2 pairs, anterior or rostral pair slightly longer than the posterior or maxillary pair. Both pairs of barbels shorter than eye diameter. Least depth of caudal peduncle 1.78 (1.66-1.85) in its length.

*Scales*: Lateral line abruptly descending, with 38-39 scales. Lateral transverse scales 12 from the pelvic origin to the dorsum 3 1/2 rows of scales between the lateral line and base of pelvic fin. 14-16 predorsal scales and 12-14 circumpeduncular scales.

*Fins*: D.ii, 7; A. iii, 11-12; P. i, 12; V. i,8; C. 19. Dorsal fin originates exactly midway between the posterior margin of the orbit and base of caudal fin. Pelvic fin commences on a vertical considerably anterior to the dorsal fin. Anal fin originates on a vertical posterior to the dorsal fin. Length of the longest dorsal ray 5.76 (5.55-6.11), length of the longest anal ray 6.62 (6.25-6.88), pectoral length 5.21 (5.00-5.50) and pelvic length 7.42 (7.14-7.85) in standard length. Caudal fin forked with unequal lobes, lower lobe longer than upper.

*Colour in alcohol*: Dorsal surface light grey and sides silvery. A light darkish longitudinal band extending from behind the head to the base of caudal fin. All the fins are hyaline.

*Distribution and Habitat* : This species is known only from the River Gumti at Udaypur subdivision, South Tripura district, North-eastern India (23°45' N, 91°30' E). The holotype and paratypes were collected with cast net from clear, mud- bottomed pools with moderate flow.

*Etymology*: For Dr. J.S. Nelson of the University of Alberta, Alberta, Canada in recognition of his valuable contribution to the study of the fishes of the world.

## DISCUSSION

*Barilius nelsoni* is similar to *Barilius evezardi* Day and *Barilius radiolatus* Gunther in lacking the vertical bars on the body and in almost same head length and body depth. It is considered to be most closely related to these species. The new species can be easily separated from the former species in the position of the dorsal fin which commences midway between the hind margin of the orbit and base of caudal fin (vs. hind edge of the orbit and posterior end of the caudal fin), barbels present (vs. absent), lower jaw conspicuously shorter than

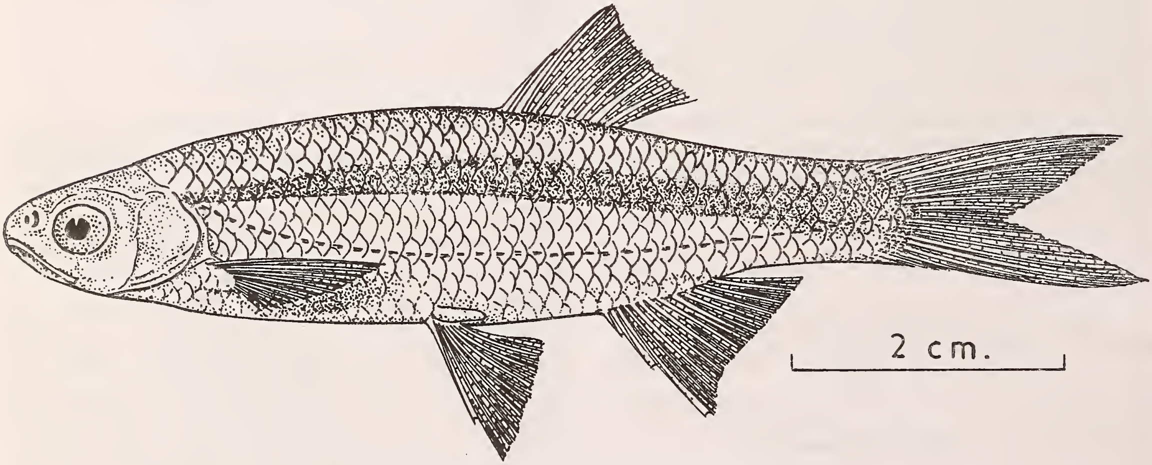

Fig. 1. Lateral view of holotype of *Barilius nelsoni* sp. nov.

the upper jaw (vs. lower jaw slightly longer), maxilla extending below up to middle of the orbit (vs. anterior margin of the orbit), caudal fin with upper lobe shorter (vs. upper lobe longer). Further, *B. nelsoni* is provided with a darkish longitudinal lateral band extending from behind the head to the base of caudal fin which is lacking in *B. evezardi*. The new species can also be separated from *B. radiolatus* by the fewer number of lateral line scales 38-39 (vs. 56-62), predorsal scales 14-16 (vs. 24-25) and circumpeduncular scales 12-14 (vs. 18).

The presence of symphysial knob on the lower jaw and general appearance of this species with the absence of the characteristic vertical bars so common in the genus *Barilius*, gives the species a close resemblance to the fishes of the genus *Rasbora* Bleeker, from which however it may be easily identified by the number of anal fin rays; while its distinctly rounded (not sharp edged) abdomen shows it does not belong to *Chela* Hamilton.

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# A NEW FROG OF THE GENUS *PHILAUTUS* GISTEL, FROM THE PROPOSED NAMDAPHA BIOSPHERE RESERVE, ARUNACHAL PRADESH, NORTHEAST INDIA[1]

S.K. CHANDA AND A.K. GHOSH[2]

(*With a text-figure*)

During the study of a large collection from the proposed Namdapha Biosphere Reserve, we came across a new species of frog of the genus *Philautus* Gistel (Family Rhacophoridae), which is described here.

**Philautus shyamrupus** sp. nov. (Fig. 1)

Colour varying from grey to brown on the dorsum. A dorsolateral white band on either side, extending from posterior region of eyes and ending posteriorly near the vent. Limbs dark brown to grey. Eyes blackish; ventral surface dirty white. A dark, narrow line originating from the interorbital region, extends posteriorly to the hindmost part of the body.

Skin smooth above. Chest and belly smooth. Ventral surface almost smooth.

Head as long as broad; snout obtusely pointed, slightly longer than eyes; canthus rostralis distinct; nostrils closer to tip of snout than eyes; internarial distance less than interorbital space which is equal to diameter of eyes; tympanum distinct, two-third of diameter of eyes;

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TABLE 1
BODY MEASUREMENTS IN MM OF FIVE SPECIMENS OF *Philautus shyamrupus* SP. NOV. FROM NAMDAPHA

| | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| Length of head and body | 25.0 | 22.0 | 22.0 | 19.5 | 19.5 |
| Length of head | 6.5 | 5.0 | 5.0 | 4.0 | 4.0 |
| Width of head | 6.5 | 5.0 | 5.0 | 4.0 | 4.0 |
| Length of snout | 4.5 | 4.0 | 4.0 | 3.5 | 3.5 |
| Length of eye | 3.5 | 3.0 | 3.0 | 2.5 | 2.5 |
| Interorbital width | 3.5 | 3.0 | 3.0 | 2.0 | 2.0 |
| Diameter of tympanum | 2.4 | 2.0 | 2.0 | 1.2 | 1.2 |
| Length of forearm | 16.5 | 16.0 | 16.0 | 14.0 | 14.0 |
| Length of first finger | 3.5 | 2.0 | 2.0 | 1.2 | 1.2 |
| Length of second finger | 4.0 | 3.5 | 3.5 | 2.5 | 2.5 |
| Length of third finger | 5.0 | 4.5 | 4.5 | 3.5 | 3.5 |
| Hind limb | 33.5 | 30.5 | 30.5 | 27.0 | 27.0 |
| Length of tibia | 12.5 | 11.0 | 11.0 | 9.4 | 9.3 |
| Length of foot | 9.0 | 7.5 | 7.5 | 6.0 | 6.0 |
| Third toe | 3.0 | 2.5 | 2.5 | 2.0 | 2.0 |
| Fourth toe | 4.5 | 4.0 | 4.0 | 3.0 | 3.0 |
| Fifth toe | 3.0 | 2.5 | 2.5 | 2.0 | 2.0 |

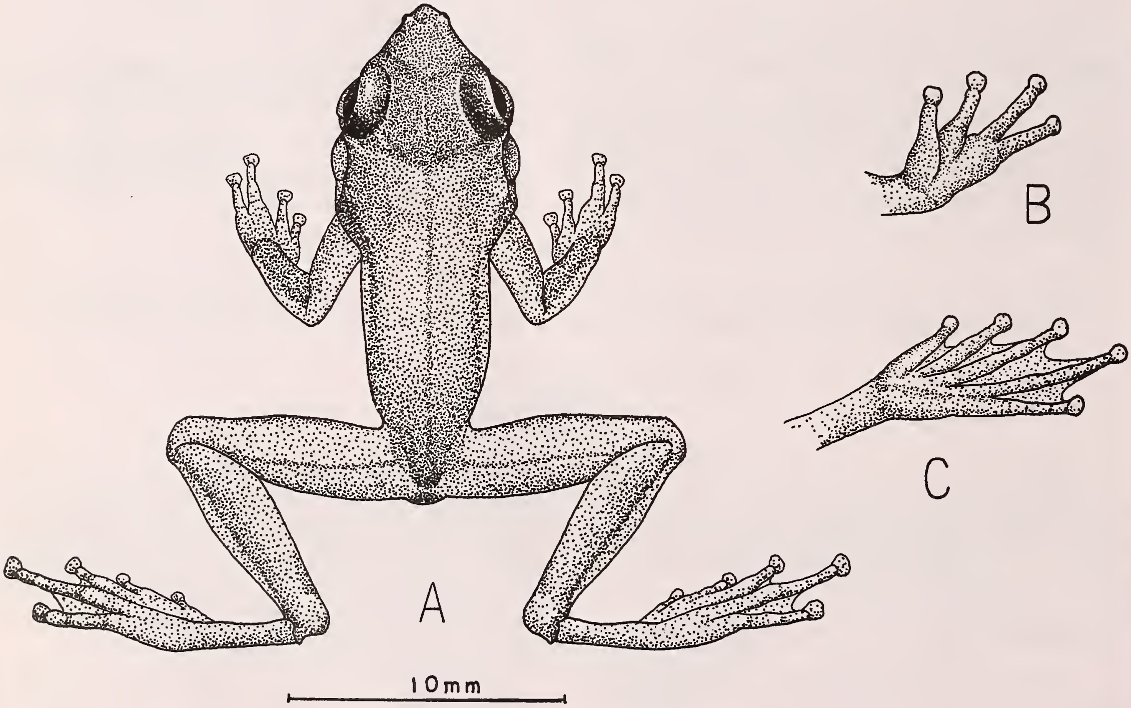

Fig. 1. *Philautus shyamrupus* sp. nov.
A. dorsal view of the body; B. ventral view of the hand; C. ventral view of the foot.

tongue free and deeply notched behind.

Forelimbs moderately long and slender; fingers free with prominent rounded tips; first finger shorter than second.

Hindlimbs fairly long; tibiotarsal articulation reaching nostrils; heels just meeting when hind limbs folded at right angles to body; tibia half the length from tip of snout to vent and three to four times as long as broad; fourth toe longest, longer than snout and with prominent discs; discs of toes broader than long; more than two-third webbed, two distal phalanges of fourth toe free; subarticular tubercles not prominent; both inner and outer metatarsal tubercles absent.

*Measurements* : See table 1.

*Holotype* : Adult female, Regd. Z.S.I. (K.Z. 313) collected from Hornbill, Namdapha Tiger Reserve and proposed Biosphere Reserve, Arunachal Pradesh; 13. xii. 1983, coll. S. Biswas.

*Paratypes* : Four adult males, Regd. Z.S.I. (K.Z. 314-317), collected from Hornbill, Namdapha Tiger Reserve and proposed Biosphere Reserve, Arunachal Pradesh, 13. xii. 1983, coll. S. Biswas.

The species is named after Dr. Shyamrup Biswas, who led the survey team to the area.

*Comparisons: Eight species of the genus Philautus* Gistel, have been described from north-east India, namely *Philautus argus* (Annandale), *P. annandalii* (Boulenger), *P. andersoni* (Ahl), *P. cherrapunjiae* (Roonwal & Kripalani), *P. garo* (Boulenger), *P. kempiae* (Boulenger), *P. namdaphaensis* (Sarkar & Sanyal), and *P. shillongensis* Pillai & Chanda. Of these, the present species appears close to *P. argus* , but can be distinguished from it in having toes that are not fully webbed; (fully webbed in *argus* ); indistinct subarticular tubercles (subarticular tubercles distinct in *argus* ) and head as long as broad (head longer than broad in *argus* . Moreover, when compared with all the species of the genus *Philautus* from the Indo-Australian Archipelago, the present species revealed some affinities with *P. aurifasciatus* (Schlegel), described from Java, but can be distinguished from it in having a much larger tympanum which is more than half the diameter of eye (one-third to nearly half in *aurifasciatus* ), nostrils much closer to tip of snout than eyes (nostrils equidistant from eyes and tip of snout in *aurifasciatus* ) and absence of inner metatarsal tubercle (inner metatarsal tubercle present in *aurifasciatus* ). A combination of four characters, namely smooth skin, nearly fully webbed toes, indistinct subarticular tubercles and absence of both inner and outer metatarsal tubercles distinguishes *Philautus shyamrupus* from both *Philautus argus* and *Philautus aurifasciatus* .

## ACKNOWLEDGEMENTS

We thank the Director, Zoological Survey of India, Calcutta for providing the necessary facilities to work on the collections and the MAB-India Committee for financing the Namdapha Project.

# A NEW SPECIES OF *PINNOTHERES* LATREILLE (DECAPODA: BRACHYURA) FROM VISAKHAPATNAM COAST OF BAY OF BENGAL, ANDHRA PRADESH[1]

K. Nirmala Devi and K. Shyamasundari[2]

( *With eight text-figures* )

A new species of the genus *Pinnotheres* Latreille is described from Visakhapatnam. The new species *Pinnotheres hanumantharaoi* is related to *P. pectinicola* Burger. The differences between *P. pectinicola* Burger and *P. hanumantharaoi* are also given.

## INTRODUCTION

The diagnostic characters of the genus *Pinnotheres* Latreille were given by Miers (1886) and Alcock (1900). Burger (1895) described about 30 new species of *Pinnotheres* and gave a key. Later Rathbun (1910) examined the *Pinnotheres* of the Gulf of Siam and added 7 new species. Tesch (1918) enumerated 65 Indo-Pacific species of *Pinnotheres* inhabiting the mantle cavity of Lamellibranchs and also provided a key to the species. Hornell & Southwell (1909) furnished a list of species of *Pinnotheres* with their respective hosts and localities where they occur. Description for a new species of *Pinnotheres placunae* which lives in *Placuna placenta* from Okha was furnished. Chhapgar (1957) described a new species of *Pinnotheres* , *P. vicajii* collected from the bivalve *Paphia malabarica* at Bombay. Another new species of *Pinnotheres* , *P. sanguinolaria* obtained from the mantle cavity of *Sanguinolaria diphos* inhabiting shallow waters of Travancore was described by Krishna Pillai (1951).

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[1] Accepted January 1988.

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## Description

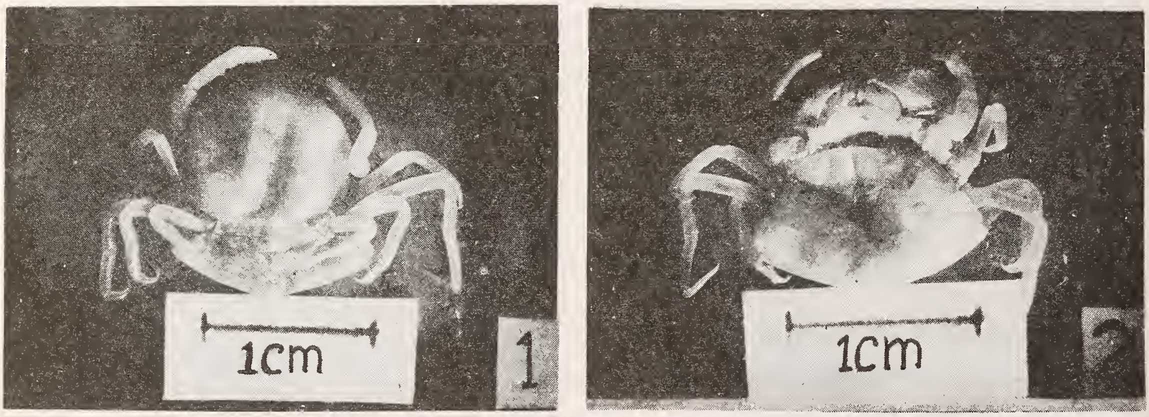
Tribe : CATOMETOPA
Family : PINNOTHERIDAE
Subfamily : PINNOTHERINAE
Genus : *Pinnotheres* Latreille

### **Pinnotheres hanumantharaoi** sp. nov.

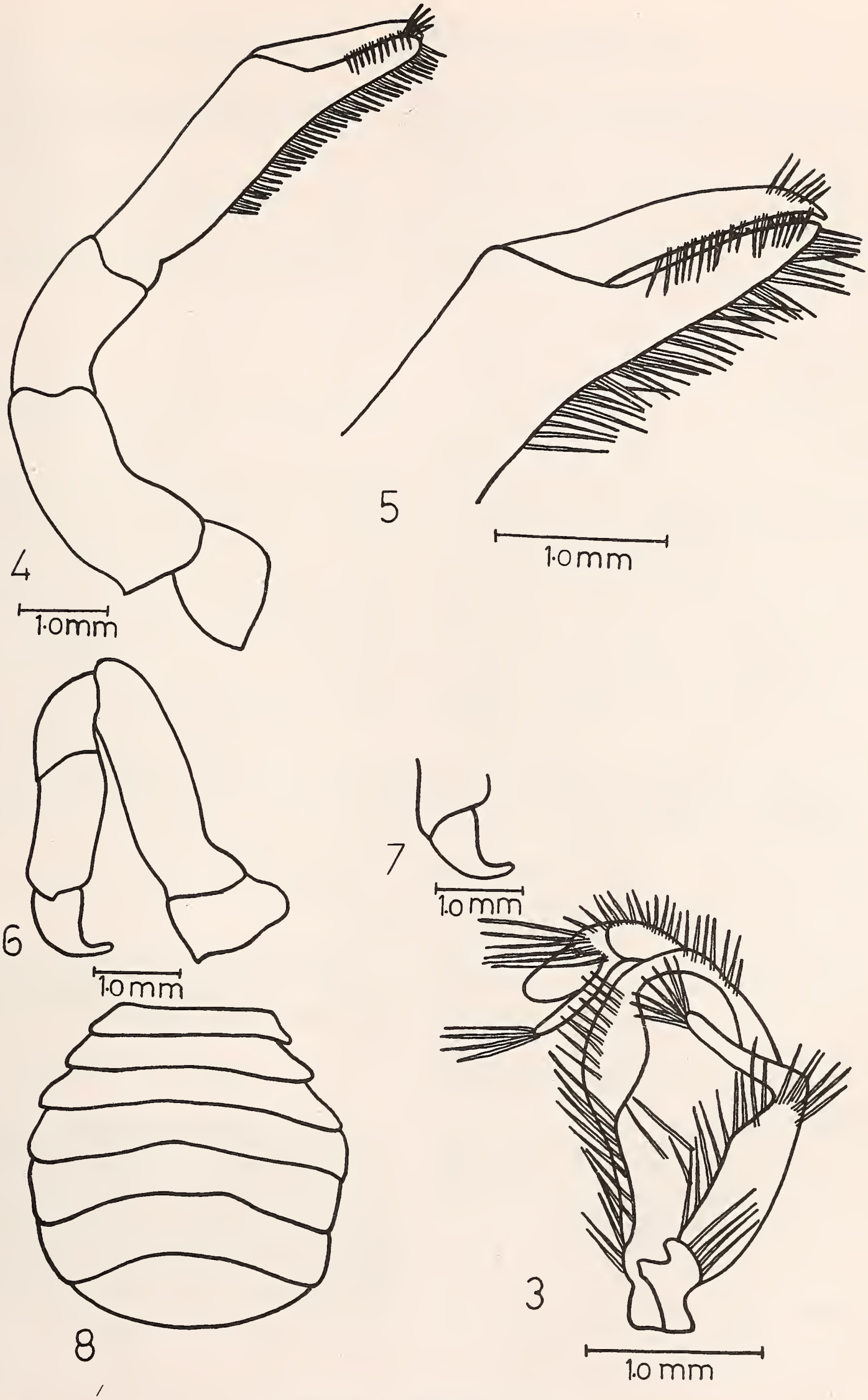
Type: *Holotype*, berried female 10 mm broad and 9 mm long.
Walking legs: see Table 1.
Paratypes:
(1) female 14 mm broad, 13 mm long;
(2) berried female 9 mm broad, 8 mmlong;
(3) female 9 mm broad, 8 mm long;
(4) berried female 8 mm broad, 7 mm long;
(5) berried female 10 mm broad, 9 mm long.
*Average measurement*: 9 mm broad and 8 mm long

Collected from offshore fishing station, Visakhapatnam, during 1979-80. They were obtained from the mantle cavity of *Pecten pleuronectes* Lamarck. 110 shells of *Pecten pleuronectes* were opened and only 20 female *Pinnotheres* could be collected. No males were ever found and it can be presumed that they are free living. The holotype and paratypes are now in the Zoology Msueum of Andhra University, Waltair. They will be deposited in the museum of Zoological Survey of India, Calcutta.

Carapace brown, subcircular, convex especially towards the middle region, regions indistinct. Carapace is smooth, completely naked without sculpture and membranous. Front is 2/5 of the breadth of the Carapace, slightly thickened and not prominent (Figs. 1 & 2). Eyes are not visible from above and are pale brown in colour. The external maxillipeds are conspicuous but covered by the seventh segment of abdomen. Merus-ischium of the external maxilliped is broad and its outer border much curved. Along the inner border of merus-ischium long hairs are implanted. The distal end of its outer border also bears long hairs. Palp of the external maxilliped is three-jointed. Carpus is shorter than the propodus. The Dactylus is inserted on the inner side of the propodus. Dactylus is narrow, styliform, reaching a little beyond the rounded distal end of the propodus; it carries a few long hairs at its tip. The outer border of carpus is curved and also lined by hairs. Exopodite is conspicuous, shorter than merus-ischium and the tip carries a



*Pinnotheres hanumantharaoi* sp. nov.
Fig. 1. Dorsal view; 2. Ventral view.


4
1·0mm
5
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6
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7
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8
3
1·0 mm

*Pinnotheres hanumantharaoi* sp. nov.
Fig. 3. Third maxilliped (right); 4. Right chelate leg; 5. Fingers of the right chelate leg; 6. Right fourth walking leg; 7. Dactylus of right fourth walking leg; 8. Abdomen.

TABLE 1
WALKING LEGS OF HOLOTYPE OF *P. hanumantharaoi* SP. NOV

| | Merus | Carpus | Propodus | Dactylus | Total |
|---|---|---|---|---|---|
| *Right:* | | | | | |
| Length of 1stleg | 3 | 2 | 2 | 2 | 9 mm |
| Length of 2nd leg | 5 | 4 | 3 | 3 | 15 mm |
| Length of 3rd leg | 3 | 2 | 2 | 2 | 9 mm |
| Length of 4th leg | 3 | 2 | 2 | 2 | 9 mm |
| Chelate leg | Arm 3 | Wrist 2 | Hand 4 | Fingers 2 | 11 mm |
| *Left:* | | | | | |
| Length of 1st leg | 3 | 2 | 2 | 2 | 9 mm |
| Length of 2nd leg | 4 | 3 | 3 | 2 | 12 mm |
| Length of 3rd leg | 3 | 2 | 2 | 2 | 9 mm |
| Length of 4th leg | 3 | 2 | 2 | 2 | 9 mm |
| Chelate leg | Arm 3 | Wrist 2 | Hand 4 | Fingers 2 | 11 mm |

few (6 to 8) long hairs (Fig. 3). Chelipeds stouter than the walking legs. The arm, wrist and outer-border of hand smooth and devoid of armature, the hand twice as long as fingers; fingers thick, tip of the movabale finger curved, posterior border of the distal half of the hand and entire posterior border of immovable finger bears hairs. The posterior two-thirds border of movable finger also carries hairs, a few hairs also near its tip (Figs. 4 & 5). Small teeth are seen at the distal part of the immovable finger.

The walking legs slender, completely naked, second pair of legs the longest, first, third and last pair of legs equal in length, the dactyli of legs except the second pair equal in length, the dactyli of the first, third and last pairs of legs as long as their propodites, the dactyli of last two pairs of legs as broad as the propodites except the tips which are narrow and incurved as hooks. The dactyli of first and second pairs of legs more slender than their propodites and curved like hooks, the dactyli of second pair longer than the dactyli of remaining walking legs (Figs. 6 & 7).

Abdomen seven-segmented, broad covering the bases of the legs, light brown, and naked without any armature (Fig. 8). Eggs numerous, brown in colour, measuring 0.264 mm in diameter.

## DISCUSSION

*Pinnotheres hanumantharaoi* sp. nov. resembles *P. pectinicola* Burger to some extent. In the key given by Burger, *P. pectinicola* comes under section I, group A which is characterised by the dactylus of second gnathopod being inserted on the inner corner of the propodus and extending slightly beyond it, and a rectangular carapace. The differences between *P. pectinicola* Burger and the present species are summarised here

The resemblances are (1) legs slender, naked, (2) tips of the dactyli of legs curved inwards, (3) the dactylus of third maxilliped extends beyond propodus, (4) dactylus of third maxilliped inserted on inner margin of propodus.

Nobili (1906) also gave a key to the species of *Pinnotheres* and described *P. pectinicola* Burger.

From the above points it is evident that it differs from *P. pectinicola* Burger and these differences are sufficient to separate it as a new species.

## ACKNOWLEDGEMENTS

We are grateful to Masatsune Takeda, National Science, Museum, Tokyo, Japan for his suggestions and Mayadebi of Z.S.I., Calcutta for providing valuable literature. One of the authors (KND) is grateful to the Department of Ocean Development, Government of India for financial assistance.

| | *P. hanumantharaoi* sp. nov. | *P. Pectinicola* Burger |
|---|---|---|
| 1. | Host-Pecten pleuronectes. | Host-Pecten radula. |
| 2. | Breadth and length of carapace 10 & 9 mm respectively | Breadth and length of carapace 8 & 7 mm respectively. |
| 3. | Carapace subcircular, convex | Carapace almost rectangular, more or less flat. |
| 4. | Eyes pale brown | Eyes lack pigment. |
| 5. | Fingers of chelipeds half the length of hand | Fingers of chelipeds as long as those of hand. |
| 6. | Second pair of walking legs longer than remaining pairs | Middle two pairs of walking legs longer than others. |
| 7. | All segments of walking not of equal length. | All segments of walking legs of equal length. |
| 8. | Hairs present along with inner border of merusischium and outer border of carpus of third maxilliped. | In the diagram given by Burger (1985), hairs are not seen on inner border of meruschium and outer border of carpus. |

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# ON SOME RARE SPIDERS OF THE FAMILY ZODARIIDAE (ARANEAE : ARACHNIDA) FROM COASTAL ANDHRA PRADESH, INDIA[1]

B.H. PATEL AND T.S. REDDY[2]

(*With two text-figures*)

The family Zodariidae, genus *Storena* and *S. gujaratensis* Tikader and Patel and *S. indica* Tikader and Patel are recorded for the first time from Coastal Andhra Pradesh. Two new species *S. arakuensis* and *S. tikaderi* are described and illustrated.

## INTRODUCTION

The spiders of the family Zodariidae are very little known from India. Simon (1893) first recorded the family from Indian sub- continent. Later Pocock (1901), Simon (1905, 1906), Gravely (1921) and Reimoser (1934) described few more species of the family from India. Recently Tikader and Patel (1975) and Tikader and Malhotra (1976) described some new species of the genera *Storena* and *Lutica* from India. In all sixteen species belonging to seven genera are known from our country.

While examining the spider collections from Coastal Andhra Pradesh, we came across four species of spiders of this family, out of which two are the new species which are described in this paper. The family, genus *Storena* and *S. gujaratensis* and *S. indica* are all recorded for the first time from Coastal Andhra Pradesh. These spiders are found under stones or dead leaves on the ground.

All the type specimens will in due course be deposited in the National Collections, Zoological Survey of India, Calcutta.

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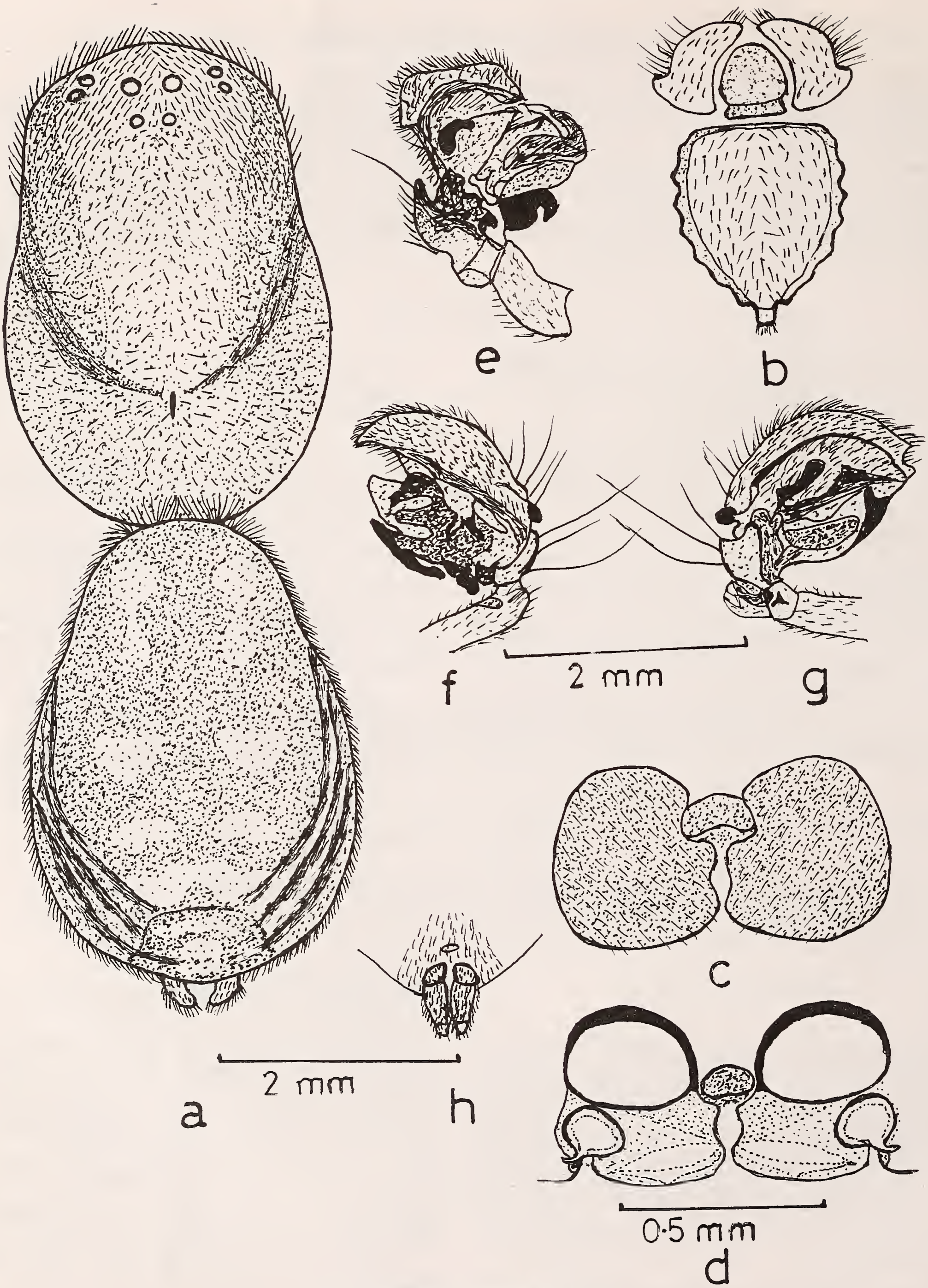

Fig. 1. *Storena arakuensis* sp. nov.
a. Dorsal view of female, legs omitted; b. Sternum, labium and maxillae; c. Epigyne; d. Internal genitalia; e. Right male palp, ventral view; f. Right male palp inner view; g. Right male palp, outer view; h. Spinnerets.

### 1. **Storena gujaratensis** Tikader and Patel 1975.

*Storena gujaratensis* Tikader and Patel, *Bull. Brit. Arach. Soc.*, *3* (5): 138.

*Specimens examined*: 2 Males, Nellore, Dist. Nellore, 13-9- 1986; 1 female, Simhachalam, 7-10-1986, and 1 female Borraguhalu, 17-10-1986, Dist. Visakhapatnam, Coll. T.S. Reddy.

*Distribution:* INDIA: Napad, Gujarat; Nellore and Visakhapatnam Dists., Andhra Pradesh.

### 2. **Storena indica** Tikader and Patel 1975.

*Storena indica* Tikader and Patel , *Bull. Brit. Arach. Soc.*, *3* (5): 137-138.

*Specimens examined*: 1 Female, Draksharama, Ramachandrapuram, Dist. East Godavari, 7-9-1986. Coll. T.S. Reddy.

*Distribution*: INDIA: Pavagadh, Vallabh Vidyanagar, Gujarat; East Godavari, Dist. Andhra Pradesh.

### 3. **Storena arakuensis** sp. nov. (Fig. 1)

*General* : Cephalothorax reddish brown, legs yellowish, abdomen brown. Total length 7.13 mm. Carpace 3.63 mm long, 2.45 mm wide; abdomen 3.50 mm long, 2.45 mm wide.

*Cephalothorax*: Longer than wide, slightly narrowing in front, anterior margin round and smooth; middle of cephalothorax provided with a conspicuous fovea. Eyes pearly white, in two rows; both rows procurved but posterior row strongly procurved with equal eyes. Anterior median eyes larger than the others, lateral eyes nearly contiguous. Posterior median eyes closer to each other than to the laterals. Ocular quad longer than wide, slightly wider behind than in front as in Fig. 1.a. Sternum heart shaped, pointed behind, clothed with fine hairs, labium longer than wide. Maxillae provided with a tuft of scopulae at the distal end. Sternum, labium and maxillae as in Fig. 1.b. Chelicerae strong and stout, short, fang groove with a small tooth on each of the two margins. Legs long and strong, clothed with hairs and spines. Tibiae and metatarsus of all legs with three pairs of ventral spines. Tarsal claws three, the median one being very small. Leg formula 4 1 2 3. Male is similar and practically of the same size of female. Total length 6.66 mm. Male palp as in Fig. 1. f and g.

*Abdomen*: Oval, longer than wide, pointed behind, clothed with fine hairs. Anterior dorsal side of abdomen provided with three pairs of conspicuous white patches and posterior end with two inconspicuous white transverse markings and with three corrugations on posterior lateral sides as in Fig. 1.a. Ventral side pale with two longitudinal brown markings. The anterior spinnerets are long and the other two pairs are comparatively short as in Fig. 1.h. Epigyne and internal genitalia as in Fig. 1.c and d.

*Holotype*: One female, *paratype* two females, *Allotype* three males in spirit.

*Type-locality*: Araku valley, Araku, Dist. Visakhapatnam, 28-9-1985. Coll. T.S. Reddy.

*Diagnosis*: This species resembles to *Storena indica* Tikader and Patel but it is separated as follows: (i) Anterior dorsal side of abdomen provided with three pairs of irregular and posteriorly two median irregular conspicuous white patches but in *S. indica* anterior dorsal side of abdomen with two pairs of oblong and posteriorly three median conspicuous white patches present. (ii) Epigyne and internal genitalia are also structurally different. (iii) The structure of male palp is differs.

### 4. **Storena tikaderi** sp. nov. (Fig. 2)

*General*: Cephalothorax and legs reddish brown, abdomen dark brown. Total length 6.53 mm. Carapace 2.72 mm long, 1.90 mm wide; abdomen 3.81 mm long, 2.45 mm wide.

*Cephalothorax*: Longer than wide, slightly narrowing in front, anterior margin round and smooth, practically without hairs except for a few spine like hairs on the cephalic region. Middle of cephalothorax provided with a conspicuous fovea. Eyes pearly white, in two rows; both rows procurved and with eyes equal in size. Anterior median eyes larger than the others, laterals nearly contiguous. Posterior median eyes closer to each other than to the laterals. Ocular quad as long as wide, slightly wider behind than in front as in Fig. 2.a. Sternum heartshaped, pointed behind, clothed with hairs. Labium longer than wide reddish, brown. Maxillae roundish, distal end light yellow in colour. Sternum, labium and maxillae as in Fig. 2.b. Chelicerae stout and short, fang groove with a single small tooth on each of the two margins. Legs long and clothed with

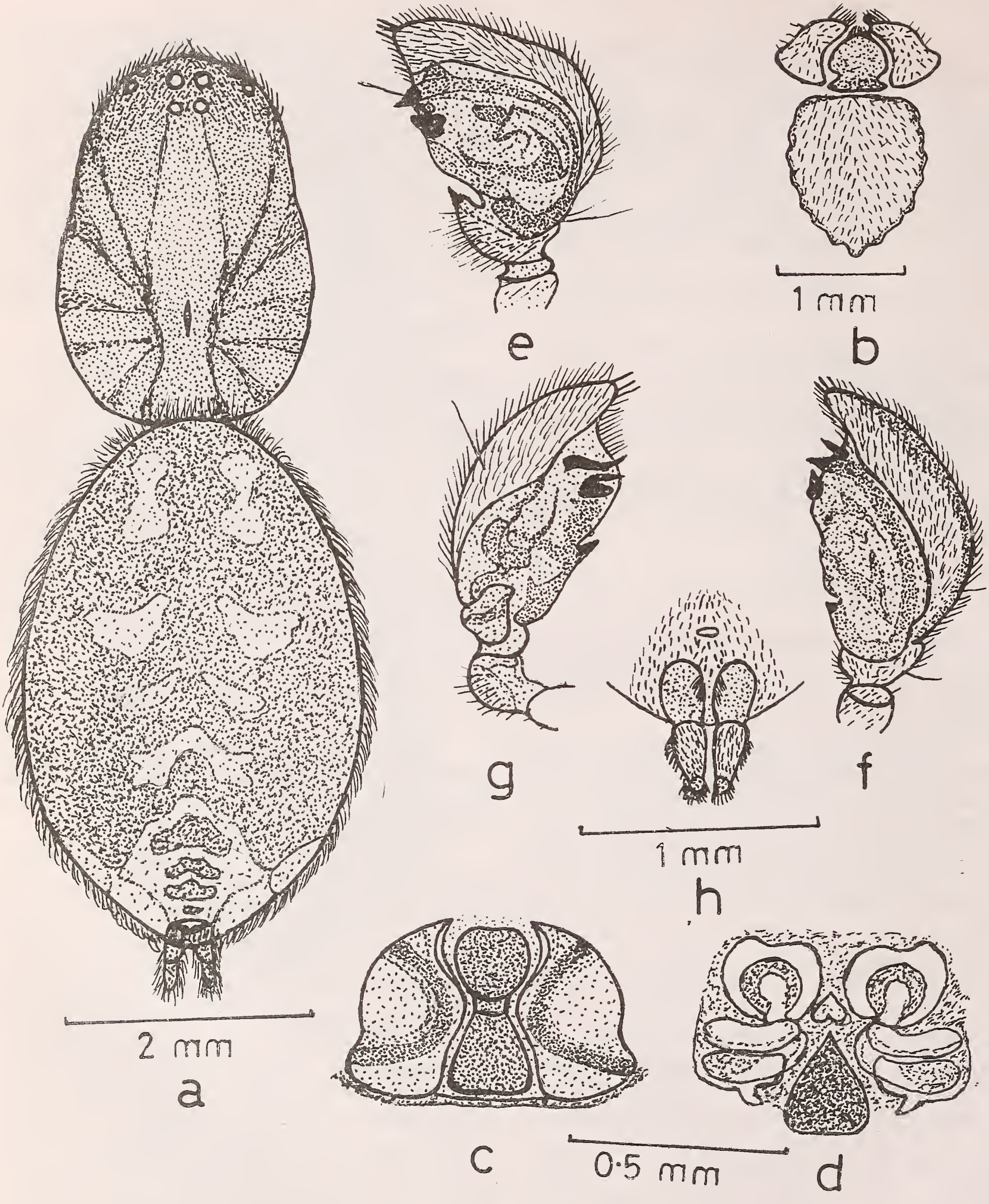

Fig. 2. *Storena tikaderi* sp. nov.

a. Dorsal view of female, legs omitted; b. Sternum, labium and maxillae; c. Epigyne; d. Internal genitalia; e. Right male palp ventral view; f. Right male palp inner view; g. Right male palp outer view; h. Spinnerets.

hairs and spines. Tibiae and metatarsus of legs I and II with three pairs of ventral spines. Tarsal claws three, the median one being very small. Leg formula 4 1 2 3. Male is similar but smaller than the female. Total length 5.35 mm. Male palp as in Fig. 2. e, f and g.

*Abdomen* : Oval, longer than wide, pointed behind, clothed with fine hairs. Anterior dorsal side of abdomen provided with three pairs of conspicuous white patches and posterior end with more than two pairs of inconspicuous white transverse markings as in Fig. 2.a. Ventral side pale in colour with two longitudinal deep brown markings. The anterior spinnerets are long and the other two pairs are comparatively shorter as in Fig. 2.h. Epigyne and internal genitalia are as in Fig. 2.c and d.

*Holotype*: One Female, *paratype* six Females, *allotype* one Male in spirit.

*Type-locality* : Araku valley, Araku, Dist. Visakhapatnam, 18-10-1986. Coll. T.S. Reddy.

*Distribution*: 2 Females, 1 Male, Tadikalapudi, Dist. West Godavari, 1-9-1985; 1 Female, Narasaraopeta, Dist. Guntur, 20-3- 1986 and 1 Female, Vellatur, Dist. Guntur, 24-3-1986; 1 Female, Borraguhalu, Dist. Visakhapatnam, 17-10-1986.

*Diagnosis*: This species resembles to *Storena arakuensis* sp. nov. but it is separated as follows: (i) The posterior cephalothorax is provided with radiating cephalic furrows but in *Storena arakuensis* sp. nov. only the cephalic groove present. (ii) The posterior dorsal side of abdomen is provided with irregular white patch but in *S. arakuensis* sp. nov. posterior dorsal side of abdomen is provided with different type of irregular white patch and also with three corrugations on posterior lateral sides. (iii) The structures of epigyne and internal genitalia are different. (iv) Structure of male palp is also different.

## ACKNOWLEDGEMENTS

We are thankful to Prof. K.B. Tipnis, Principal, Sir P.P. Institute of Science, Bhavnagar for providing laboratory facilities and encouragements. One of us (TSR) is also greatful to the Government of Gujarat for financial assistance.

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# TWO NEW SPECIES OF *SKIMMIA* (RUTACEAE) FROM ARUNACHAL PRADESH, INDIA[1]

ANIL K. GOEL[2] AND B.N. MEHROTRA[3]

(*With two text-figures*)

Two new species, *Skimmia arunachalensis* and *S. kamengensis*, from West Kameng district of Arunachal Pradesh in the Eastern Himalayas are described. Their diagnostic characters with *S. arborescens* are discussed and the key for the identification of five Indian Skimmias, is provided.

## INTRODUCTION

Rutaceae are represented by 150 genera with 900 species. They are distributed in tropical and warm temperate regions, particularly in South Africa and Australia (Heywood 1978). *Skimmia* Thunb. has about 18 species, mainly from Japan, China, India, Nepal, Bhutan, Pakistan, Afghanistan, Formosa, Burma, Thailand and the Philippines. So far, three species, namely *S. laureola* (DC.) Sieb. & Zucc., *S. arborescens* T. Anders. ex Gamble and *S. melanocarpa* Rehder are known from the Indian subcontinent (Gamble 1917, Hara 1965). *S. laureola* is distributed in the whole Himalayan range and the other two species are restricted to the Central and Eastern Himalayas.

During the course of plant collection from West Kameng district of Arunachal pradesh, under the biological screening programme of the Central Drug Research Institute, two interesting species belonging to *Skimmia*, were collected. On critical identification at CAL, DD, CDRI, Assam, LWG and a scrutiny of the literature, they were found to be distinct from the known species of *Skimmia*. The two species are described and illustrated here.

### **Skimmia arunachalensis** sp. nov. (Fig. 1)

*Skimmia arborescenti* affinis, sed differt petiolis 0.5-1.0 cm longis, paniculis parvis, 0.6-1.2 cm longis, petalis oblongis 3.0-4.0 mm longis, antheris majoribus, 2 mm longis, drupis majoribus, 9-13 mm diam., subglobosis, rugosisque in pedicellis *Holotypus lectus a A.K. Goel* sub numero 14216 A, ad locum Bomdila, Kameng occ., alt. 2500 m, die April 2, 1984, et Isotypi *A.K. Goel* 14216 B-D, positi in herbario C.D.R.I. Lucknow.

Small glabrous, evergreen trees *c.* 3-4 m high. Twigs bright green. Leaves alternate or crowded towards the end of branches, simple, petiolate; petioles 0.5-1.0 cm long; lamina 4.5-14.0 x (1.0-) 2.0-3.5 cm, lanceolate or oblong lanceolate, acuminate to caudate with cuneate, sometimes oblique base, thinly coriaceous, sparsely gland dotted on both surfaces, nerves indistinct on both sides. Panicles small, dense, terminal or axillary, 0.6-1.2 cm long. Flowers yellowish white, polygamous, subsessile or pedicellate. Pedicels 1.0-1.5 mm long, thick. Bracts and bracteoles 1.5-2.5 x 1.0-2.0 mm, ovate, acuminate, with ciliate margins. Sepals 5, imbricate, 2.0-2.5 x 1.0-1.5 mm, broadly ovate, with ciliate margins, persistent in fruits. Petals 5, 3.0-4.0 x 1.0-1.5 mm, oblong, obtuse. Stamens 5; anthers 2.0 x 0.75 mm, yellowish, dorsifixed; filaments *c.* 1.25 mm long, white, stout, subulate. Ovary ovoid, rudimentary in male flowers; styles divided at top in 3 short stigmatic branches, *c.* 0.5 x 0.5 mm, white; female flowers; only 1-2 develop in subglobose drupes. Pedicels enlarged in fruits, 5-10 mm long. Drupes 9-13 x 7-13 mm, rugose with *c.* 1-2 mm diam. stigmatic scar on top. Seeds ovoid 6-7 x 4-5 mm, whitish cartilagenous.

*Flowers & Fruits*: March – June.

*Habitat* : On open or shady slopes alongwith *Salix* along forest edges.

This species is allied to *Skimmia arborescens* T. Anders. ex Gamble but differs in having small, 0.5-1.0 cm long petioles; 0.6-1.2 cm long panicles; petals oblong, 3.0-4.0 mm long; anthers larger, 2 mm long; drupes large, 9-13 mm diam., subglobose, rugose on *c.* 1.5 mm thick pedicels.

*Type*: INDIA: Arunachal Pradesh: Bomdila

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[1] C.D.R.I. Communication No. 4004. Accepted December 1987.

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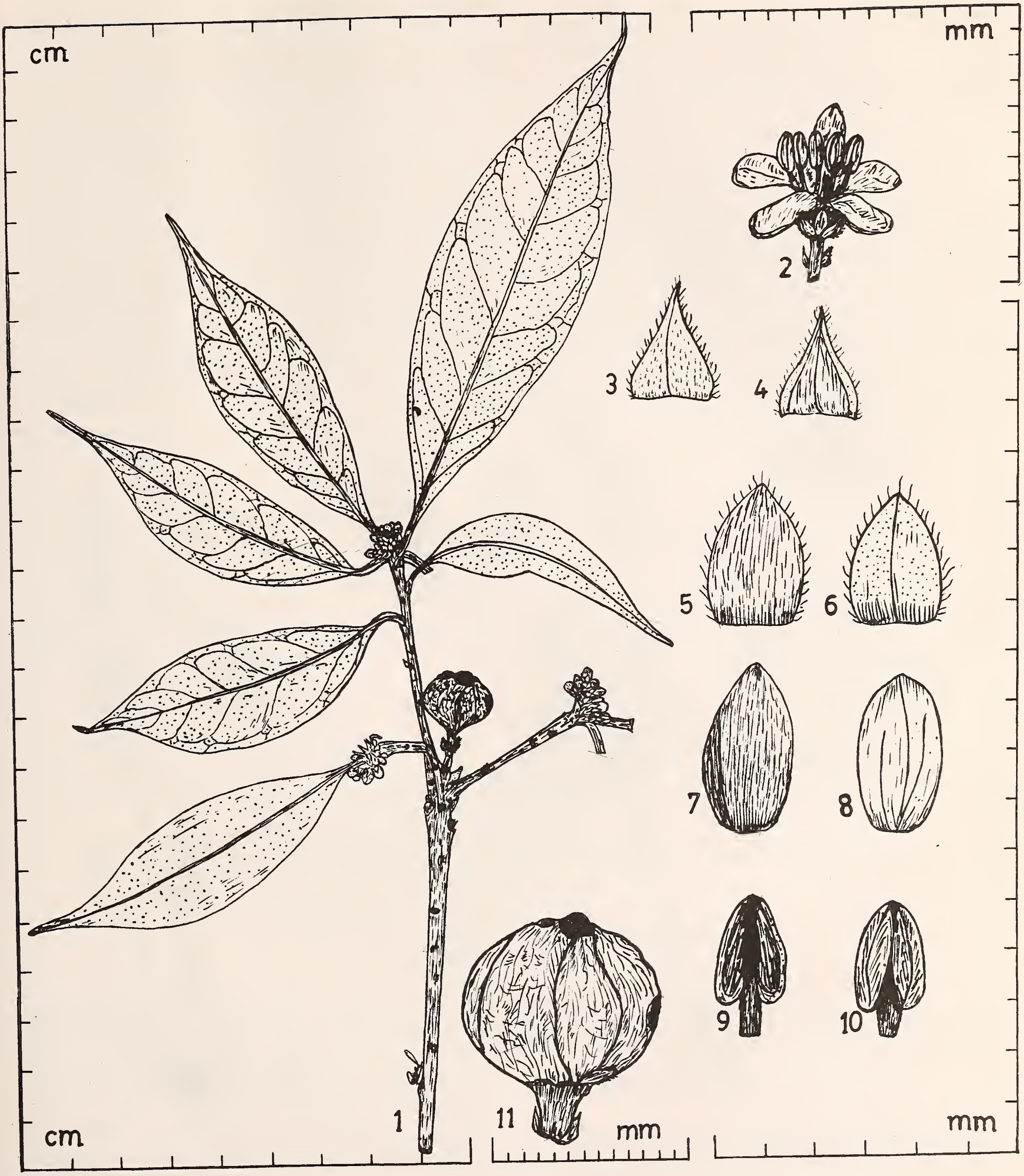
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Fig. 1. *Skimmia arunachalensis* sp. nov.
1. Habit; 2. Flower; 3 & 4. Dorsal & ventral view of bract; 5 & 6. Dorsal & ventral view of sepal; 7 & 8. Dorsal & ventral view of petal; 9 & 10. Stamens; 11. Fruit. (Anil K. Goel, 14216 — A, CDRI).

(West Kameng Dist.) 2500 m, April 2, 1984, *A.K. Goel* 14216 A (Holotype); *A.K. Goel* 14216 B-D (Isotypes) - CDRI; Bomdila Camp, April 13, 1957, *G. Panigrahi* 6885 A-D (Paratypes) - CAL.

### **Skimmia kamengensis** sp. nov. (Fig. 2)

A *Skimmia arborescenti* facile distinguibilis petiolis parvis, 0.8-1.5 cm longis, foliis obovato-oblongis, coriaceis, cum 10-20 nervis lateralibus non arcuatis secus marginem; paniculis majoribus, 5.0-8.0 cm, laxis, bracteis parvis, 1.0-1.5 mm longis, sepalis 1.0-1.5 mm longis, marginibus non ciliatis, drupis atro-viridibus, parvioribus, 3.0-6.0 mm diam., pyriformibus.

Holotypus lectus a *B.N. Mehrotra* sub numero 2446 A, ad locum Bomdila, Kameng occ., alt. 3048 m, die May 5, 1970, et Isotypi *B.N. Mehrotra* 2446 B-C, positi in herbario C.D.R.I. Lucknow.

Small trees. Leaves alternate or crowded at the ends of branches, simple, petiolate; petioles 0.8-1.5 cm long; lamina 7.0-14.0 x 2.5-4.2 cm, obovate oblong, acute to obtuse with cuneate base, coriaceous, sparsely gland dotted below, thickly gland dotted above; midrib thick, prominent on both surfaces; lateral nerves indistinct. Panicles lax, terminal, branched, hispid, 5.0-8.0 cm long, many flowered. Flowers cream coloured. Pedicels 3-10

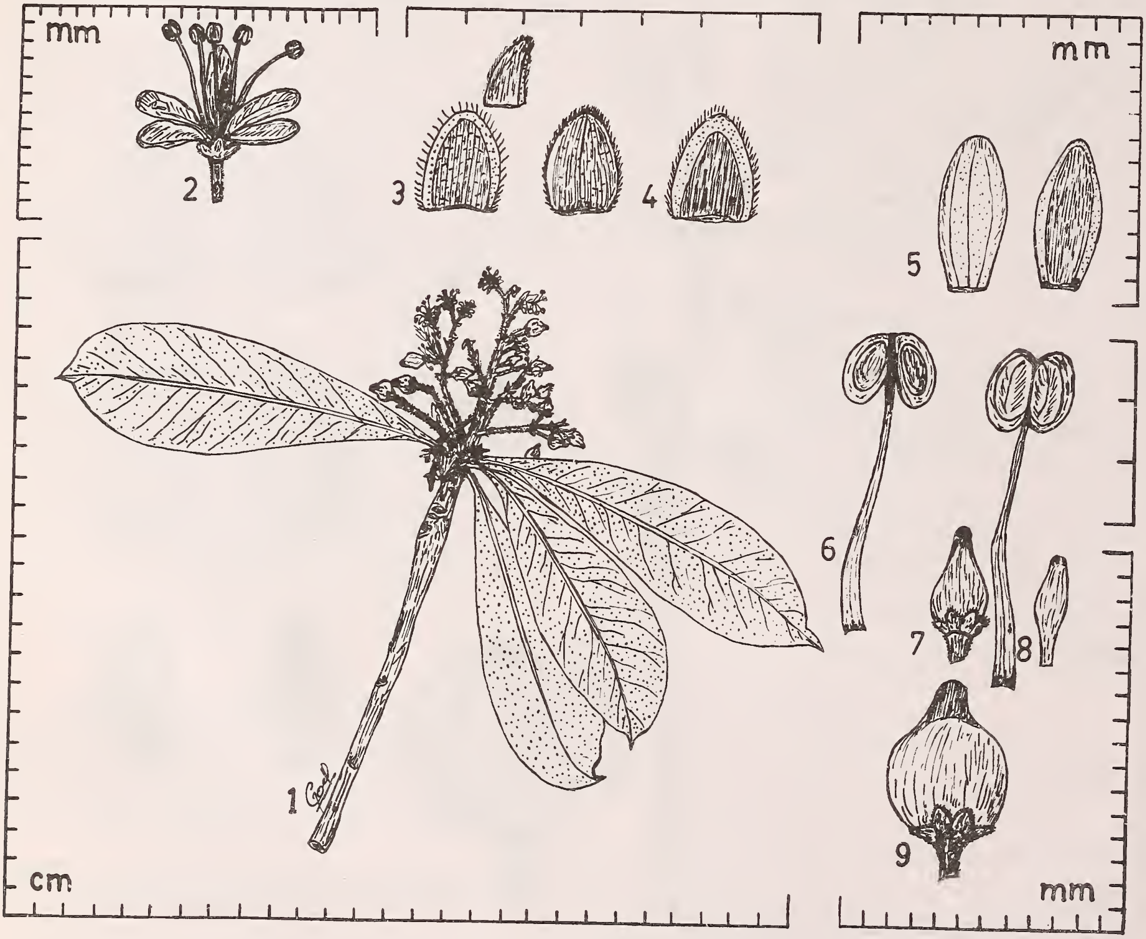

Fig. 2. *Skimmia kamengensis* sp. nov.
1. Habit; 2. Flower; 3. Bracts; 4. Sepal in dorsal & ventral view; 6. Stamen in dorsal & ventral view; 8. Gynoecium; 7 & 9. Fruits.
(B.N. Mehrotra, 2446 — A, CDRI).

mm long, thick. Bracts and bracteoles 1.0-1.5 x 1.0 mm, ovate, acute with ciliate margins. Sepals 5, imbricate, 1.0-1.5 x 1.25 mm, broadly ovate, obtuse, tomentose with ciliate margins, persistent in fruits. Petals 5, 5.0-6.0 x 1.0-2.0 mm, spathulate, thick, obtuse. Stamens 5, excerted; anthers 2-lobed, 0.75-1.0 x 0.75-1.0 mm, yellowish, dorsifixed, opening longitudinally; filaments 4.0- 5.0 mm long, stout, subulate, white. Ovary small, fixed at 0.75 mm across disc, 2 celled; style *c.* 2 mm long, stout; stigma single, capitate. Drupes pyriform, 3.0-6.0 mm across. Seed 1, cartilagenous.

KEY FOR IDENTIFICATION OF FIVE SPECIES OF *Skimmia*

1a. Low trees; leaves caudate, acuminate, thinly coriaceous:
  2a Anthers larger, 2 mm long; fruits 9.0-13.0mm diam., subglobose, rugose ........................ *S. arunachalensis*
  2b. Anthers smaller, 0.5 mm long; fruits less than 9.0 mm diam., globose, smooth........................*S arborescens*
1b. Shrubs; leaves acute to obtuse, thickly coriaceous:
  3a. Flowers in lax panicles; fruits pyriform..............................................*S. kamengensis*
  3b. Flowers in dense panicles; fruits ovoid to globose:
    4a. Leaves elliptic, smaller; drupes black.......................................*S. melanocarpa*
    4b. Leaves oblong elliptic, larger; drupes dark red..................................................*S. laureola*

*Flowers & Fruits*: April - June.

*Habitat*: On shady slopes.

It can be readily distinguished from *S. arborescens* by small 0.8-1.5 cm long petioles; obovate oblong, coriaceous leaves with 10-20 lateral nerves, without arching along margins; panicles larger, 5.0-8.0 cm, loose; bracts small, 1.0-1.5 mm long; sepals 1.0-1.5 mm long with ciliate margins; drupes greenish black, smaller 3.0-6.0 mm diam., pyriform. With the discovery of these two new species, the total number of taxa described under *Skimmia* rises to twenty; of these, *S. laureola* is distributed over the whole Himalayan range and *S. arborescens*, *S. melanocarpa*, *S. arunachalensis* and *S. kamengensis* are reported from the Central and Eastern Himalayan regions of the Indian subcontinent. To facilitate the identification of the above five species occurring in India, the following key is provided:

## ACKNOWLEDGEMENTS

We thank the Director, Central Drug Research Institute, Lucknow for facilities and Dr. N.C Majumdar, Regional Botanist, Botanical Survey of India, Howrah, for help in the Latin diagnosis.

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# *ERIA LOHITENSIS* — A NEW SPECIES OF ORCHID FROM ARUNACHAL PRADESH, INDIA[1]

A. NAGESWARA RAO[2], K. HARIDASAN[3] AND S.N. HEGDE[2]

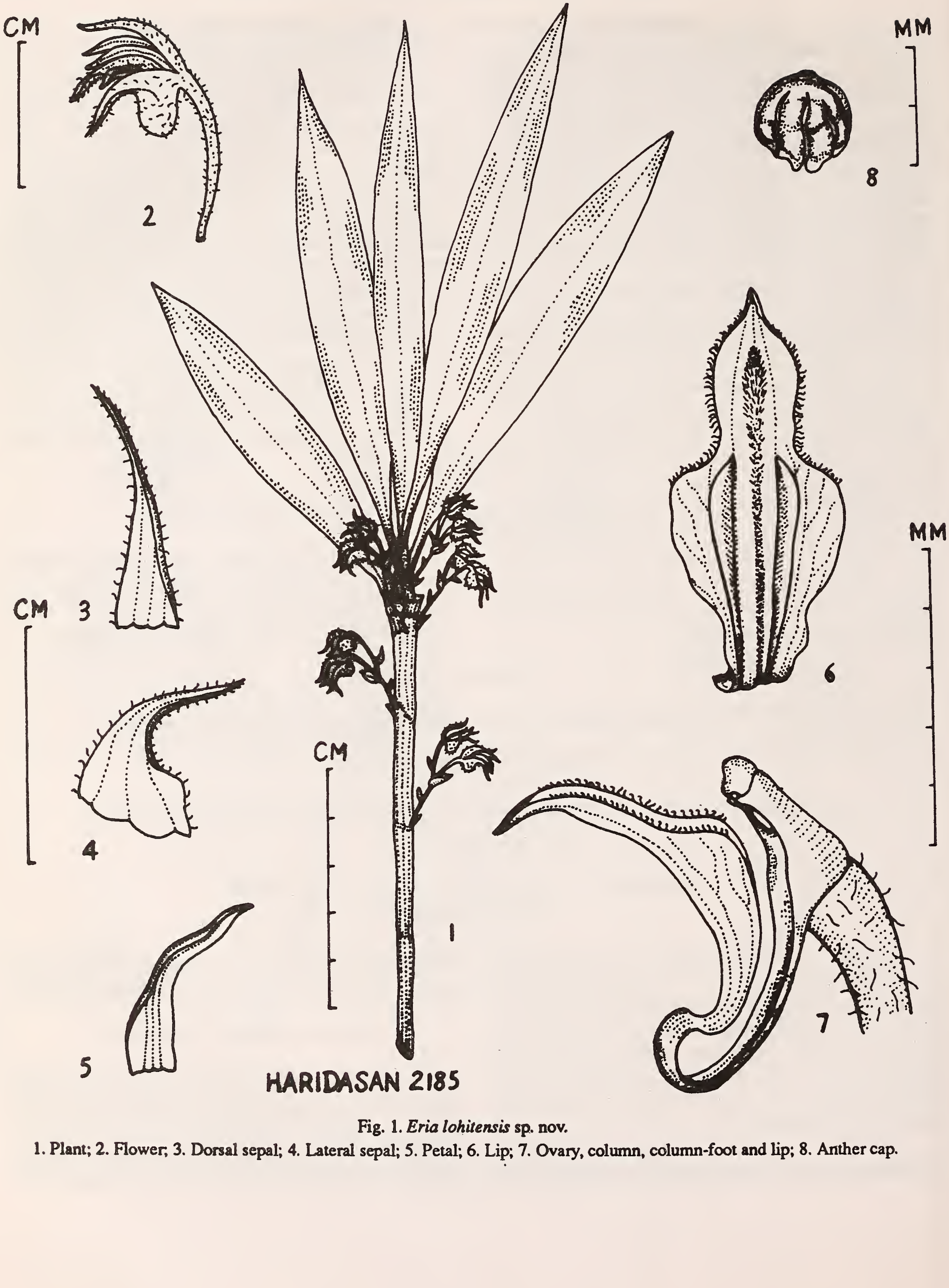
( With a text-figure)

During a collection trip to Lohit district of Arunachal Pradesh, one of us (Haridasan) collected an orchid belonging to the genus *Eria* Lindl. A critical study based on the regional herbarium specimens of allied species and also literature on Asiatic species of *Eria* has proved it to be quite distinct from species so far known. Hence it is described here as a new species.

The new species belongs to the section *Cylindrolobus* Bl. of the genus *Eria* and can at once be distinguished from the rest of the species of the section by the presence of lip with ciliate midlobe.

### **Eria lohitensis** sp. nov. (Fig.1)

Affinis *E. cristata* Rolfe, a qua imprimis differt sepalis acuminatis trinervis, labelli lobis medio oblongo ciliato. Holotypus: lectus ad locum Mailang - Mithumna, alt. 1600 m, die 11-5-1985, *Haridasan* 2185 (Arunachal Forest Herbarium).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HARIDASAN 2185

Fig. 1. *Eria lohitensis* sp. nov.
1. Plant; 2. Flower; 3. Dorsal sepal; 4. Lateral sepal; 5. Petal; 6. Lip; 7. Ovary, column, column-foot and lip; 8. Anther cap.

Epiphyte. Stems about 20 cm long and 8 mm thick, clavate. Leaves upto 6, terminal, about 15 x 2 cm, oblong-lanceolate, acuminate, shortly petioled. Inflorescences many, arising laterally from the stem at various intervals from middle on the stem to subterminus. Inflorescence 2-flowered, about 3.5 cm long. Rachis white pubescent, with two sterile bracts at short intervals. Floral bract about 8 x 4 mm, shorter than the pedicellate ovary, acute. Flowers about 2 cm long, white. Dorsal sepal about 10 x 2 mm, lanceolate, acuminate, white pubescent outside, 3-nerved. Lateral sepals about 10 x 5 mm, obliquely ovate-triangular, acuminate, forming a mentum with the foot of column, white pubescent outside, 3 nerved. Petals about 8.0 x 1.5 mm, oblong — lanceolate, acute to acuminate, 3-nerved. Lip about 7 mm long 3 mm broad across the lateral lobes, shorter than the sepals and petals, 3-lobed; lateral lobes 4 mm long, rounded, with 2 prominent parallel vertical lamellae inbetween on the disc; midlobe 3 mm long, oblong, acute, ciliate at margins, with a median vertical hairy ridge on the disc. Column about 2 mm long, with a long foot which is in curved at apex. Anther cap semiglobular, 4-celled. Ovary with pedicel about 1 cm long, white pubescent.

*Flowering*: May.

*Occurrence*: Arunachal Pradesh, Lohit district, Mailang - Mithumna (1600 m).

*Distribution*: Endemic.

*Eria lohitensis* is allied to *E. cristata* Rolfe which is reported from Burma and Thailand but can be easily distinguished from the latter by the presence of acuminate, 3- nerved sepals instead of acute, 5-nerved sepals and oblong ciliate midlobe of lip instead of broadly ovate midlobe of lip which is entire at margin.

## ACKNOWLEDGEMENTS

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# REVIEW

## BIRDS TO WATCH: THE ICBP WORLD CHECKLIST OF THREATENED BIRDS by N.J. Collar & P. Andrew. ICBP Technical Publication No 8, pp. xvi + 303 + ii. Cambridge, England. 1988. £ 9.50 inclusive of packing and postage.

This publication is the latest in the ICBP's new series of regional bird Red Data books on threatened birds and offers a concise but comprehensive collection of listings, easy to cross–check within and between chapters, coupled with short, precise notes. There are no illustrations except on the front cover.

Some regions seem to be covered more thoroughly than others. Species accounts have been listed according to current literature available; at times, the authors have gone beyond current literature. The senior author obtained from this reviewer the latest information on the status of the Jerdon's or Double–banded Courser *Rhinoptilus bitorquatus*. Thus, the correspondence also finds a place in the listing.

Over 11% of the world's nearly 9,000 avian species, i.e. 1.000 species are "to varying degrees at risk from global extinction. When viewed on a global level, the presentation is highly disturbing." The threat to avian species underlines the threat to the habitat and the ecosystem. "Since the destruction, modification and fragmentation of habitats are by far the most common types of threat, there is no reason to assume that other life forms — plants, insects and lower animals — that share the habitats of these threatened birds are any better off. The birds are in fact just the tip of the iceberg, concealing thousands of other species we know little or nothing about."

From the global scene to India: there are 69 avian species listed as threatened, of which 15 are endemic to India. Some of the paragraphs accompanying the listings (related to the Indian region and the Indian Ocean area) are very interesting and need to be recorded here.

Amsterdam Albatross *Diomedea amsterdamensis* is confined as a breeding bird to Amsterdam Island (French territory) in the southern Indian Ocean, where an average of merely five pairs breed every year.

Mascarene Black Petrel *Pterodroma aterrima* is known only from Reunion Island (French territory) by four specimens collected in the nineteenth century and three birds found dead in the 1970s, and by subfossil remains on Rodrigues Island (Mauritius) in the Indian Ocean.

Greater Adjutant Stork *Leptoptilos dubius* has suffered catastrophic decline everywhere, probably no longer occurring in Burma or Thailand, not recently recorded from Vietnam, extinct in Bangladesh, and extremely rare in India, where the only breeding records (and the only recent ones anywhere) are from Assam.

Pinkheaded Duck *Rhodonessa caryophyllacea* is regarded as extinct. Last sighted at Bihar in June 1935; the possibility that a small population survives in a remote region was raised, and dropped, but rumours persist.

Himalayan or Mountain Quail *Ophrysia superciliosa*. The last specimen was in 1876 and the species is presumed extinct, yet perhaps survives.

Lesser Florican *Sypheotides indica* is restricted as a breeding bird to primary grassland patches. Its non-breeding distribution in India is not primarily known.

Nicobar Pigeon *Caloenas nicobarica* Its status is hard to assess as its habitat is infrequently visited and it is known to wander amongst groups of islands, but it is known to have declined markedly in parts of its range.

Rothschild's Parakeet *Psittacula intermedia* was long based on seven skins of uncertain provenance but recently one or two live specimens, reputed to have come from the plains of Uttar Pradesh, have appeared each year in bird markets in India.

Forest Owlet *Athene blewitti* is known from very few specimens, the last of which was collected in 1914.

Rufousnecked Hornbill *Aceros nepalensis* is probably extinct in Nepal, reportedly declining in India and restricted to two forest reserves in southwest Thailand.

Narcondam Hornbill *Aceros narcondami* is an endemic resident of Narcondam in the Andaman Islands where the population is estimated to be about 400 individuals.

Rustythroated Wren-babbler *Spelaeornis badeiqularis* is known only from the type-specimen, taken at 1,600 m in the Mishmi Hills, Arunachal Pradesh.

The authors point out in the introductory chapter that the Red Data Books published earlier received unwelcome commentary like "the publication of Red Data Books may be guilty of engendering a degree of complacency" (*Kukila* 3 (1988):77). The authors add that there it took considerable effort to make the analyses as thorough and truthful as possible given the urgency imposed by limited resources. Feedback was time-consuming, "so later evaluations had less time to benefit from written dialogue". The authors admit that "in some cases the selection and rejection of species became necessarily speculative, though certainly never arbitrary". Finally, the authors stress that "the 1,029 species listed here as threatened are all unquestionably birds to watch, birds to seek out, survey, monitor and conserve".

BHARAT BHUSHAN

# MISCELLANEOUS NOTES

## 1. A PRELIMINARY NOTE ON THE SURVIVAL STATUS OF HANUMAN LANGUR (*PRESBYTIS ENTELLUS*) IN SOME VILLAGES OF NADIA DISTRICT, WEST BENGAL

### INTRODUCTION

The Hanuman Langur (*Presbytis entellus*) is distributed from Kashmir to Kerala and from Kathiawar to Assam. Sixteen subspecies are recognised (Pocock 1931, Ellerman and Morrison-Scott 1951 and Napier and Napier 1967), of which fourteen are found in India. From its habitation in various geographical areas of India, it appears that *P. entellus* is the most highly adaptive primate species among the monkeys of the Cercopithecidae family. Vogel (1977) has rightly mentioned that *P. entellus* occupies a broader spectrum of habitats than other macaques. The distribution and abundance of *P. entellus* is not well investigated in West Bengal. Oppenheimer (1973) made a study on village dwelling langurs in West Bengal (Proceedings of the Indian Science Congress Association (Abstract)). Surveys of villages in Hooghly, Howrah and Purulia districts of West Bengal during 1972-1973 revealed the presence of *P. entellus* (Oppenheimer, Akonda and Hussain 1983). The distribution of *P. entellus* is probably widespread in West Bengal; one of the authors (A.B.) has observed it in the districts of Murshidabad, Birbhum, Burdwan, Hooghly, Howrah, Midnapur and 24-Parganas. We initiated a survey of *P. entellus* in the state of West Bengal in respect of its distribution and abundance. The present communication is a part of the project related to the field work in Nadia, a southern district of West Bengal. Interestingly, we had first taken up this particular district as one of us (B.R.) is a resident of one of the villages where the field work was conducted. According to B.R. *P. entellus* has existed in villages for many years; his grandfather used to see these animals during his childhood. He is of the opinion that the number of these village dwelling *P. entellus* is gradually decreasing. This personal observation by B.R. kindled our interest to investigate the reasons for this gradual decrease in numbers..

### MATERIALS AND METHODS

Our area of field work consisted of four villages, Gotepara, Nutan Gotepara, Mirzapur and Nakashipara in the district of Nadia, West Bengal, 140 km. from the city of Calcutta and 5 km from Bethuadahari railway station on the Sealdah-Lalgola line. The villages are situated at 88.2° E longitude and 23.80° N latitude. National Highway 34 passes only 7 km away to the north- east of the villages. The villages are, surrounded by paddy fields, and each village has many gardens with mango, banana, jackfruit, coconut trees etc. Some well-to-do villagers of Nutan Gotepara and Mirzapur possess very big gardens with the above- mentioned trees. Moreover, tall trees of *Ficus religiosa* and *Ficus bengalensis* are found in all the villages.

This communication is based on intensive collection of field data over 84 hours (approx.) of direct observation on free living *P. entellus* in these villages from 9 to 15 June 1987. On an average, 12 hours observation per day, from 0600 to 1800 hrs.., was made by both of us on the monkeys once they were located in the villages.

### RESULTS AND DISCUSSION

The size and composition of the groups identified by us independently after repeated verification are shown in Table 1.

The monkeys found in the villages Nutan Gotepara, Mirzapur and Nakashipara; Gotepara and Nutan Gotepara were termed as Group A, B and C respectively. Group A, a unimale bisexual group, consisted of 32 individuals and was the largest. Group B, a unimale bisexual group, consisted of 11 individuals and Group C, an all male group of 6 individuals. With an alpha male in Group A, all adult females except one were seen to have infants varying in age from 10 to 30 days (approx.). Group B, which is

TABLE 1
SIZE AND COMPOSITION OF GROUPS INHABITING VILLAGES

| Group | Location | Adult males | Adult females | Juveniles | Infants | Total |
|---|---|---|---|---|---|---|
| A | Nutan Gotepara, Mirzapur and Nakashipara | 1 | 14 | 4 | 13 | 32 |
| B | Gotepara | 1 | 7 | 1 | 2 | 11 |
| C | Nutan Gotepara | 6 | - | – | – | 6 |

smaller than A had an alpha male and only two females with infants. Interestingly, Group C was an all male group and the individual members were adult and strong. The villagers called Group C by the traditional Bengali name of *Sanyasi Pal* which means all of them, in a group, were unmarried males like monks in human society. The diets as found by direct observation are presented in Table 2.

TABLE 2
PLANTS AND PLANT PARTS OBSERVED BEING EATEN BY *Presbytis entellus*

| Name of plant | Parts eaten |
|---|---|
| *Artocarpus integrifolia* | Ripe jack fruits |
| *Mangifera indica* | Ripe mangoes |
| *Ficus religiosa* | New green leaves |
| *Ficus bengalensis* | New green leaves |
| *Saccharum officinarum* | Matured stem of plant |
| *Musa sapientum* | Ripe banana |
| *Corchorus olitarious* | New green leaves |
| *Bombax* sp. | Flower petals |
| *Trewia nudiflora* | Fruits |

The daily rhythm of activities of Groups A and B appears to be more or less the same (Prater 1965 and Krishnan 1972). Although *P. entellus* is quite at home both in trees and on the ground, our observations are in accordance with Oppenheimer (1973), who found that in Bengal villages they spend more time in trees. Group C was observed at midday for two and half hours on two successive days on 13 and 14 June on a very high tree of *Ficus religiosus* at Nutan Gotepara. This group was not found on any other day in the villages covered by our field study, thereby indicating that they probably move to other nearby villages. The movement of individuals of Group A is restricted to the adjoining villages of Nutan Gotepara, Mirzapur and Nakashipara whereas individuals of Group B confine themselves to the village of Gotepara. Thus the home range of Group C appears to be greater than that of Groups A and B.

The abundance of food resources in the large gardens having different types of trees (Table 2) may probably be one of the major reasons why the langur groups studied chose these villages as their permanent settlement over a considerable period of time. The villagers report that with seasonal changes, especially in winter, these animals change their diet by consuming varieties of vegetables cultivated in the villages. During the field observations it was almost confirmed that Group A and Group B limited their foraging to their respective villages. Intragroup encounters were not observed during the short period of field observations.

Besides B.R.'s personal experience mentioned earlier, the older generation of villagers agreed that the *P. entellus* population had gradually decreased in the area. In the causes for this decrease the following observations appear to be relevant. During the 12 hours observation on an average per day on either Group A or Group B, we noticed that villagers tried to protect their gardens from the foraging langurs. On an average the monkeys are driven away 4 to 5 times in a day from the gardens of villages Nutan Gotepara, Mirzapur and Nakashipara. The same is true in the case of Group B. It was noted that when the monkeys of Group A were disturbed and driven away from a garden in Nutan Gotepara, they moved to another garden in the same village. If similarly threatened they moved to the garden in the adjoining village Mirzapur and when again driven away they move to the gardens of Nakashipara. This kind of harassment of the monkeys of Group A and B prevent them from foraging as noted during our field work. The villagers do not wish to harm the langurs due to their sacred place in Hindu mythology, but are forced to drive them away to protect their valuable garden products such as mango, jackfruit, banana, coconut etc. from which they earn the major part of their livelihood. The monkeys occasionally destroy growing jute plants by eating the green leaves, and naturally the poor farmers desperately try to save their jute plants from the monkeys. It was observed that the monkeys of Group B when similarly threatened move from one garden to another in the same village, Gotepara, which is comparatively larger than Nutan Gotepara, Mirzapur and Nakashipara. As mentioned earlier, Group B, which is smaller in size than Group A, has a single large village as its habitat. The villagers reported to us that *P. entellus* at present sometimes consumes food on moonlit nights. *P. entellus* is diurnal as is suggested by the published literature. Feeding by night is thus a very unusual habit caused probably by the fact that the animals are disturbed so much by villagers when foraging that they are compelled to consume food at night. In all villages the monkeys were seen to eat fruits of Pituli (*Trewia nudiflora*). According to the elders of the villages this fruit has become an item of food in the very recent past.

The villages under study can be traced back to the days of the Apostle Sree Krishna Chaitanya of Nabadwip and therefore the villages near the bank of the old river bed of the Bhagirati are approximately five hundred years old. In the past, the present Nadia district was covered with vast forests. One of the positive evidences for this statement is the 7 sq.km Bethuadahari Reserve Forest, which is merely 5 km away from the villages of our study. It is only after independence and the division of Bengal that the Hindu refugees from East Pakistan (now Bangladesh) settled in this district. Nadia is at present a border district with Bangladesh. Gradually, a substantial portion of the forests of the district has been converted into settlements and cultivated by this migrant population. The population pressure of the migrants was so acute in the past three or four decades in the villages of our study that many large gardens as (for example 'Roybagh') have totally vanished and have been converted into cultivated land in Gotepara. The gradual deforestation for cultivation and settlement by man in this region has had a severe impact on the survival of the langurs. Threat to the survival of monkeys by direct or indirect interference by man is reported in literature in the Indian context. Sugiyama and Parthasarathy (1978) found a significant decrease in langur population at Dharwar by comparing populations of the years 1961 and 1976. According to them this decrease was in cultivated land (open land) due to increased human impact on langurs.

Southwick and Siddiqui (1983) suggested that deforestation, increased agricultural development and human population growth were responsible for decline of rhesus populations in Uttar Pradesh.

We conclude that deforestation for cultivation and human settlement in this part of Nadia district, along with direct human interference, has had an adverse impact on the village dwelling langurs, leading probably to decreasing population.

A.B. DAS-CHAUDHURI

April 5, 1988. B.N. ROY

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## 2. AN INTERESTING WAY OF A TIGER TREATING ITS WOUND

Injuries a tiger tries to heal can be classified into the following three categories:

(a) Those which can be licked by the tongue,

(b) those which cannot be licked but can be reached by front paws, and

(c) those where neither tongue nor paw can reach.

Application of saliva through the tongue cleans the wounds and keeps away flies. This does not permit the maggots to set in, and the wound gradually dries up. Such wounds are licked many times in a day and each time the duration of continuous licking is quite long. Body parts where the tongue cannot reach are cleaned by licking a front paw several times, and then wiping the wound with the paw. The forehead is the region where this method is applied. Carnivores face real trouble when the injured part is out of reach of tongue or front paw. The shoulder region around the spine is one such place.

A friend of mine with a good knowledge of wildlife has told me that injured tigers sometimes eat soil. On 13 May 1987, while observing the mating behaviour of a pair of tigers at Kanha National Park, I saw that the male tiger had an injury above its left shoulder just below the vertebral column. This tiger was seen scratching its wound with its rear paw. This seemed to aggravate the wound. For three days male and female were together around the same spot. On the last day the tiger left the tigress and went to a waterhole. I followed, and saw the tiger sitting flush with the ground in a thicket of grass on a *nala* bed. From elephant-back it looked as if he was eating something. The tiger rolled over and got up after some time. A dark coloured paste was visible on his lips. Since the tiger was after a tigress in oestrous, I thought that he might have licked the urine - spray of the tigress from the ground. The tiger then took some more water at a second waterhole, climbed a little bit on open ground, again sat flush with the ground, and started chewing the soil (clayey-loam).

This process continued for about a minute. The soil paste in the mouth was not put on the floor. Then the tiger crept forward, drifted a bit to the side and rolled over the 'sput-out' paste of soil in such a way that the paste was applied over the wound. It is likely that tigers treat their unreachable wounds, not by eating soil, but by applying soil on the wound in form of a paste mixed with saliva.

May 10, 1988 A.S. PARIHAR

## 3. ON A HUNTING PAIR OF SNOW LEOPARDS IN WESTERN NEPAL

Hunting attempts by snow leopard (*Panthera uncia*) have been observed by several naturalists (Dang 1967, Haughton 1913, Schaller 1972, Shah 1986, Stockley 1928 and Ward 1923). Among others, Dang (1967) reported repeated sightings of pairs of snow leopards hunting and feeding together. Other observers, however, neither support nor refute this viewpoint. Recently I observed a pair of snow leopards hunting together in the Langu valley of western Nepal.

On 10 May 1987, at 0750 hrs, I was monitoring the daily activity pattern of a herd of 41 Himalayan tahr (*Hemitragus jemlahicus*) in the Langu valley of western Nepal. The animals were feeding and moving horizontally on a steep (more than 40°) scrub slope at 3 300 m. At 0755 hrs I saw an adult snow leopard slowly descending towards the feeding tahr. When the snow leopard was about 20 m above the tahrs it started stalking. At 0756, I saw another adult, but smaller, snow leopard descending through the same route used by the previous one. For convenience I will call the larger snow leopard as leopard A and the smaller one as leopard B. When the smaller snow leopard neared the larger one, it moved to the right and, without stalking, descended towards the feeding tahr. When about 10 m, from the uppermost feeding tahr, it made a sudden rush and chased them straight downwards. Leopard B and the tahr ran about 120 m downwards and once the snow leopard was as close as 3 m to one of the large adult males. But it could not attack as it was off balance. At last the leopard halted on a small rock and looked upwards. Then leopard A started chasing downwards the tahr individuals which had moved to the left when leopard B had given chase. The running tahrs and leopard A passed around the waiting leopard B but the latter could not attack the tahrs due to their high speed. Leopard A could not catch the tahr either, and finally halted 20 m below leopard B. The entire chase sequence by both the snow leopards lasted less than two minutes.

When leopard A stopped, leopard B started moving upwards. After climbing about 50 m it again started stalking, facing downwards. Leopard A also started climbing up and once it happened to get to within 30 m of 11 tahrs, mainly males, on the steep cliff, standing just above the snow leopard. The tahrs gave warning calls and stamped their feet. The snow leopard stared and then ignored them. When leopard A joined leopard B it stopped stalking and both leopards started moving upwards through the pine forest. Before they disappeared into dense pine forest, they were seen sitting and looking back on three occasions. Once, leopard B squatted on the way, which confirmed that it was a female. Though I was observing them from a distance of about 3 km, judging from body size and dominant nature I am sure that leopard A was a male. After the snow leopards disappeared, I saw that the tahrs had divided into three small herds and were busy feeding. One hour later one of the herds was seen feeding exactly on the same slope where the snow leopard had stalked and given chase.

Radio-tracking and study of pugmarks had confirmed the snow leopard's solitary nature in the Langu valley of western Nepal. The species appears to associate as mating pairs and as adult females with dependent offspring. Here, mating of snow leopards takes place between January and March (Jackson and Shah 1984). According to Schaller (1977), snow leopards in the Himalaya usually court in March and April and give birth in June and July, but he also mentions observing snow leopard cubs born in August. The gestation period averages 96-105 days (Kitchener *et al.* 1975, Marma and Yunchis 1968). Captive snow leopards are born between April and August, with a peak in May to June (Freeman and Hutchins 1978). These suggest that my observation in the Langu valley could be a late mating season pair of snow leopards. Captive snow leopards breeding pairs remain together for 2-3 days (Schaller 1977). The hunting pair I observed may therefore have been a breeding pair.

December 14, 1988. KARAN BAHADUR SHAH

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## 4. CARACAL (*FELIS CARACAL* SOHROBER) SIGHTED IN PANNA FORESTS

I was searching for a man-eater with a search light on the night of 16 March 1987, in Panna district, Madhya Pradesh, when the gleam of a pair of eyes attracted my attention. Initially, from a distance, I thought it was a jungle cat (*Felis chaus*), which is common in the area. As I went nearer, the animal stood up and gave me a frontal view; then it turned to run away, allowing me to observe its tail as well.

Its colour was sandy brown, with whitish underside; the ears were large and tapered. I could not see the ear tuft. The legs were long and the tail hung down almost to the knee of the rear limbs. The tip of the tail (about 10 cm) was darker than rest of the tail.

A few years earlier, H.S. Pabla, the then Director of Panna National Park, was able to procure a skin of caracal (*Felis caracal*) from the same area. There is no doubt in my mind that the animal I saw was a caracal. Ajit Sonakia, the then Director, Sanjay National Park, Sidhi, had also two years earlier seen a caracal near Raisen, while driving at night from Bhopal to Sagar.

According to Prater (1948, THE BOOK OF INDIAN ANIMALS), the caracal is common in the north and northwest of Cutch and in the drier parts of Punjab, Rajasthan, Uttar Pradesh and Central India.

On the basis of this evidence, it can now be said that, continuing from Rajasthan and Gujarat (Cutch), caracal are found upto Bhopal, Raisen, Sagar and Panna districts of Madhya Pradesh, and are confined to the Vindhya mountains in Madhya Pradesh. They have not been seen in the Satpuda range on the southern side of the Narmada River.

May 10, 1988. A.S. PARIHAR

## 5. SOME INTERESTING ASPECTS OF WOLF (*CANIS LUPUS* LINN.) BEHAVIOUR OBSERVED AT GUDA NEAR JODHPUR (RAJASTHAN)

While on a survey to assess Blackbuck habitats in Rajasthan we were told about a pack of wolves that inhabited an area not far from Guda village. The village has a Bishnoi settlement were the Blackbuck and chinkara have been protected through local sentiments. The local forest guards claimed that there were about 13 wolves in the vicinity.

We sighted a wolf on 9 June 1987 at 0700 hrs near a small waterbody frequented by Blackbuck. Its approach was heralded by a scattering of the animals and birds that were in and around the water. The wolf came out of the area, which is overgrown with *Prosopis juliflora,* and headed for the water. The animal was in good condition and appheavier than the wolves one of us has observed in Maharashtra. It loped quickly over about 45 m of open space looking straight ahead, and had not noticed us sitting motionless on the opposite bank. As it approached to within 5 m of the water's edge its gait changed, and in a slow crouching fashion it entered the water and sat down. At this point it either saw us, or heard the click of the camera shutter. Jumping hastily out of the water it headed back the way it had come, using a small watercourse as cover.

The sighting made us want to learn more about the wolves. On 14 June at 0600 hrs we headed for the area with the local forest guard, a Bishnoi who was very well versed with local conditions and wildlife.

We found 3 lair sites. They all had been dug in more or less the same way. Each lair consisted of 2 to 4 tunnels dug into sandy mounds around *Prosopis* bushes. One of them had certainly been used very recently. The openings appeared small when compared to the height of a wolf, indicating that they enter and leave by crouching or creeping. (This would be similar to the way the wolf we observed on the previous occasion creeping into the water.) Wolf pugmarks of various sizes were seen entering and leaving the holes. Thus we concluded that a family was using the lair.

We located fresh pugmarks of a wolf moving rapidly and followed the tracks around several *Prosopis* bushes into a small clearing. Here there were marks of a scuffle, in which the wolf's paw marks were intermixed with the hoofprints of a chinkara. There was very little blood and no evidence of the kill being eaten on the spot. The wolf, after making the kill, had dragged it off over several sand dunes and dry watercourses for about a kilometer in more or less a straight line. On either side of the pugmarks was a single line of hoof marks, indicating that the wolf was strong enough to lift its prey and carry it with 2 of its legs off the ground. We came across the dismembered head of an adult male chinkara. Only the skull & horns were left. The dragmarks continued over another 100 m towards a raised area on the bank of a river bed. Here the wolf was apparently joined by several others, as indicated by tracks converging from different directions. The hooves, legbones, and parts of the skin and tail of the chinkara were all that was left. Every scrap of meat had been cleaned off the bones.

Another interesting feature we came across was that there were the remains of at least 5 or 6 (probably more) old kills in the area. The wolves seemed to have used the raised river bank frequently as an eating area. The other kills were remains of a male chinkara, several females or young male chinkara, and a peacock. Wolf faeces found in the area also contained what appeared to be hair of hare.

A most unusual find, not far from the eating place, was a small hole dug in the bed of the dry river. There were wolf tracks all around it. At the bottom of the hole (which was not as large as the lair burrows seen earlier), there was a little water. The guard informed us that the wolves dug such holes to get water from the river bed. I cannot recall a reference to any animal apart from elephants digging for water in dry river beds. The Forest Department personnel who were with us have promised to look into this, to confirm if these are actually dug for water, or for some other purpose.

The wolves at Guda feed more frequently on the chinkaras. Adult Blackbuck are probably more difficult to bring down. However, since wolves in other areas are known to predate upon fawns of Blackbuck, one cannot exclude this possibility at Guda. We found no remains of Blackbuck during this brief visit.

The present population of wolves does not seem to adversely affect the number of prey animals. Chinkara and Blackbuck abound in the area, and are as plentiful as in areas where there are no wolves.

The wolves at Guda prefer the heavily overgrown *Prosopis* bush country to the more open areas. This gives them adequate cover and an opportunity to dig lairs in the sand dunes.

The sandy soil in the area makes tracking an easy task, but the heavy bush cover decreases visibility. In all probability the wolves had spotted us and either moved off, or holed up, before we could see them again.

ERACH BHARUCHA
KIRAN ASHER
July 3, 1987. RAJEEV JUGTAWA

## 6. A NOTE ON THE PYGMY SHREW, *SUNCUS ETRUSCUS*

A Pygmy Shrew, *Suncus etruscus*, was rescued from a small tank in an open field at village Narhe, about 10 km from Pune, on 20 November 1987. It was swimming actively, and on lowering a long stick it immediately climbed out and was taken to Pune.

It was reared in an empty aquarium, 30 cm x 60 cm x 30 cm, already provided with a somewhat wet soil bed and a small tubular tunnel (burrow) about 1.5 cm in diameter, open at both ends, in one corner. The animal lived for 15 days in captivity and died, apparently from cold, on 5 December 1987.

Imediately after death, weight and measurements were noted as follows:

**Sex** : **Male, Weight** : 1.4 g, **Head and Body** : 4 cm, **Tail** : 3.3 cm, **Height of the ear pinna** : 0.4 cm.

Teeth full grown with transparent enamel revealing a portion of the pulp. Colour black-brown dorsally, whitish ash ventrally including tail. Furry coat covering all the body but tail. Ear pinnae large, moveable, with many folds and pockets. While on the move or alerted, ear pinnae are stretched out. Side/musk/flank glands, though present, were not found to produce the foul smell which is so pronounced specially in males of the Common House Shrew *Suncus murinus*. No sound was uttered by the shrew even when disturbed or irked by soft whistling or blowing air.

In captivity it was offered a variety of food: insects, egg (raw/boiled), dry prawns etc. The shrew preferred insects, mainly cockroaches. Egg was accepted with reluctance, while the dry prawns were totally disregarded.

On becoming aware of the victim, possibly by smell, ( as revealed by constant vibratile movements of the snout), the shrew would leave the burrow, walk a little distance, then quickly turn back. This was repeated several times, each foray taking it further from the burrow than the previous one. Finally it chased the victim, attacking the head first, seized and killed it. The kill was usually carried into the burrow and then consumed. The Pygmy

Shrew seems to lack the ability to dig, since termites and other insects normally found underground were left unconsumed.

I am grateful to Dr. M.S. Pradhan, Mammologist Zoological Survey of India, Pune, for confirming identification of the specimen.

July 17, 1988. R.V. RANADE

## 7. SIGHT RECORDS OF IBIS AND STORKS IN KERALA

During the latter part of 1986 and early 1987, there were quite a number of sightings of.birds altogether new to the checklist for Kerala. There were two records each for the Black- Stork (*Ciconia nigra*) *and White Ibis* (*Treskionis aethiopica*), and several for the White Stork (*Ciconia ciconia*) and the Openbill Stork (*Anastomus oscitans*), though the latter two species, of course, are not really new additions *per se*.

On 7 January 1987, I came across a solitary Black Stork at Chamravattom, about 2 km upstream River Bharathapuzha from its river mouth. Among others, many Ringed Plovers, Lesser Sandplovers, Small Indian Pratincoles, Brahminy Kites and a plethora of Pariah Kites were seen in the neighbourhood of the Black Stork, which was standing by the edge of a small inundated pool in an otherwise extensive mudflat of the riverbed.

On 24 February 1987, I was told about a new bird at the boat- landing of the Periyar Wildlife Sanctuary. On verification, it turned out to be yet another sight record of the Black Stork. Three Whitenecked Stork (*Ciconia episcopus*) siblings, which had started flying about from their nest in the neighbouring tree since about a month earlier were seen to have been feeding side by side with the Black Stork. The bird was first shown to me by an Amsterdam tourist, Mr. Jan de Groot and I subsequently had the bird photographed.

It was at Purathoor, near the Bharathapuzha estuary, that the White Ibis was seen (20 March 1987). On the extensive sandbank beside the shallow waters of the winding river was a large flock of about 160 Blackheaded Gulls (*Larus ridibundus*), and standing nearby were the four white Ibises.

Ferguson (*J. Bombay nat. Hist. Soc. 16*: 14) had reported that he had come across the White Ibis only during the cold weather at Sasthamcottah in 1904. Since then there have been further sightings. When I communicated the sighting of the White Ibis to Prof. K.K. Neelakantan, the ornithologist, he said that he had seen the bird only once at Palghat in the early 1950s, soon after the Malampuzha Reservoir was filled for the first time. After that, he had not seen any except on the other side of the Ashambu hills.

A few members of the Calicut Chapter of the Kerala Natural History Society have been subsequently able to see the White Ibis after repeated perambulation of the Bharathapuzha estuary, when they finally spotted a group of 8 White Ibises on 5 April 1987. They were said to have been able to even photograph the birds! White Stork, a very rare vagrant to Kerala* have been repeatedly met with towards the latter part of 1986, A solitary White Stork was caught from a Minister's residence at Trivandrum City on 16 September 1986. On the 21st of the same month 3 specimens were caught from a paddy field near Neyyattinkara, out of which one was reportedly killed and consumed by the local villagers, and the rest brought to the Trivandrum Zoo.

About 27 White Ibises were found in a paddy field near Iringalakkuda on 16 December 1986 (*Pers. comm.*, V.J. Zacharias) and from the zoo authorities at Trivandrum, I gathered that they had procured a specimen of the White Stork from Kesavadasapuram in Trivandrum City three years earlier, in 1983.

In 1986 and 1987 there had been repeated sightings of the Openbill Stork, (*Anastomus oscitans*) both singly and in flocks of as many as 38 individuals, from the Kadalundy estuary and the neighbouring wetland habitats (*Pers. comm.*, Sri Namasivayan).

On 19 November 1986 the Trivandrum zoo authorities went and collected a specimen of the Openbill Stork caught by local villagers in Neyyattinkara Taluk of Trivandrum District. According to Ferguson (1904, *loc.cit* 16:15) "The Openbill Stork is very common in Travancore, where huge flocks may be met with on the marshy borders of all the large tanks and fresh water lakes, sharing the trees for roosting with flocks of darters". Since then its status seems to have altered considerably. It is found now only sparsely and in small numbers.

June 3,1987. D. NARAYANAKURUP

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1A specimen of the White Stork was observed roosting on a coconut tree in Suheli Valiyakara, when I made a one-day survey of this uninhabited a toll of the Lakshadweep Group in 1985.

## 8. A POSSIBLE RANGE EXTENSION OF HORSFIELD'S GOSHAWK *ACCIPITER SOLOENSIS* IN INDIA

A Horsfield's Goshawk (*Accipiter soloensis*) was sighted by us on 24 March 1987 in Simlipal Tiger Reserve, Orissa. The bird was seen circling above the thick semi-evergreen forest near the check-post of the core area near the Chahala rest house. Three more individuals of the same species were seen during the next four days in different parts of the reserve. One of the birds was sighted near the Chahala rest house on a dead tree and was probably hunting. Another bird was sighted near upper Barakamara rest house, flying over a forest clearing. The third was sighted about 40 km outside the tiger reserve near Jasmipur forest rest house circling and constantly calling "ti- tui", quite like a shikra.

The bird was identified by its smaller-than-shikra size, white underparts with pinkish tinge on the abdomen, upper breast and underwing coverts. The underparts were unbarred. The tip of the primaries were black. The sides of the head and neck were very pale.

Horsfield's Goshawk has not so far been recorded from the Indian mainland. Ali and Ripley (1983) described its range as "uncertain, common (winter?) on Katchal Island and Great and Little Nicobar Is. (Abbott and Boden Kloss). Andaman Is."

Our sight record is probably the first proof that this species occurs in mainland India also.

ACKNOWLEDGEMENTS

We are thankful to Prof. Biswamoy Biswas of the Zoological Survey of India and Mr. H. Abdulali of the BNHS for going through the manuscript and making useful suggestions

April 29, 1987.

VIBHU PRAKASH
ASAD R. RAHMANI

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## 9. RINGTAILED FISHING EAGLE FEEDING ON WASP LARVAE

On 25 September 1986, in the Keoladeo Ghana National Park, Bharatpur, I saw a Ringtailed Fishing Eagle (*Haliaeetus leucoryphus*) sitting on a *Prosopis spicigera* tree-top near the aquatic area holding an unidentified object in its claws. I moved closer without disturbing the bird and saw that it was holding part of the nest of a paper wasp (*Polistes hebaeus*, Family : Vespidae). It was holding the nest firmly in its claws and feeding from the chambers. The Ringtailed Fishing Eagle is known to feed on birds, reptiles and fishes (Ali and Ripley 1983), and this observation of feeding on paper wasp larvae seems to be noteworthy, as it has not been recorded in the past.

This unusual food may have had something to do with the delayed arrival of migratory waterfowl as well as the unsuccessful nesting in the heronry in 1986.

November 3, 1986.

C. NANJAPPA

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## 10. RANGE EXTENSION OF EURASIAN GRIFFON VULTURE *GYPS FULVUS*

The northeastern distributional range of the Fulvous or Eurasian Griffon Vulture *Gyps fulvus* within India has been given by Ali and Ripley (1978) as "straggling east to Western Assam. Gauntlet (1985) records it in Damodar Valley in West Bengal. Grubh (1986) mentions it as occurring in northeastern India without giving details of the location of the find.

However, we had an excellent opportunity to see this bird repeatedly over a period of 2 months from November to December 1985 in Tezpur (Assam) and again between 14 and 17 January 1986 in Dibrugarh which is almost the north-easternmost limit of Assam.

We saw only upto three birds together at any time. They were all in immature plumage, the ruff being brown, and were seen in a mixed flock of *G. indicus* and *G. bengalensis*, actively feeding at cattle carcasses or sitting on trees near the feeding sites.

PRAKASH RAO
ROBERT B. GRUBH
S. MURALIDHARAN

February 17, 1986.

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## 11. OCCURRENCE OF REDBREASTED FALCONET *MICROHIERAX CAERULESCENS* (LINNE) IN THE SIMLIPAL TIGER RESERVE, ORISSA

A Redbreasted Falconet *Microhierax caerulescens* (Linnaeus) was sighted by us in the Simlipal Tiger Reserve in Orissa on 25 March 1987 at about 0700 hours. The bird was seen perched about 12 m high on a dead branch of a tree near a perennial stream close to the rest house in Upper Barakamara. The bird was readily identified by its diminutive size, broad white collar on the hind neck and a prominent black band through the eye.

The Redbreasted Falconet is not recorded earlier from Orissa. According to Ali and Ripley (1983) the species is present in the Himalayan foothills and terai from Kumaon in Uttar Pradesh to Nepal, Sikkim, Bhutan and Assam. The westernmost record is from Nainital (79° 26' E) and the southernmost record from Sultanpur (26° 15' N). The Simlipal Tiger Reserve is quite south of the known range of this species.

VIBHU PRAKASH
ASAD R. RAHMANI

March 31, 1987

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## 12. MYSTERIOUS DEATH OF DEMOISELLE CRANES (*ANTHROPOIDES VIRGO* ) AT VEER DAM

I have been studying the Demoiselle Cranes (*Anthropoides virgo*) for the last four years at Veer Dam Lake, situated 65 km from Pune on the Satara Road. Since 1984 the Demoiselle Cranes have been very regular visitors to this lake. The birds start arriving in small flocks of a few hundreds from the middle of November and their number is fairly large by January. They leave by the end of March. Every year about 2000 cranes settle here; but this year over 7000 arrived at Veer Dam. This sudden rise in numbers could be due to drought and drying up of the lakes in the north and more severe winters in the north.

The banks of the Veer Dam lake slope gradually towards the water, and are submerged in the rainy season. As the water level recedes the farmers from the neighbouring village start cultivating crops within the area. The cranes, on arrival at Veer, feed on the sprouting shoots of maize, wheat and gram, which are the chief crops of this area. Later, during February and March, the cranes feed on seeds of jowar, wheat and gram.

The farmers use different methods in order to protect their crops from the cranes, such as putting scarecrows in the field, trying to drive away the flock by shouting, throwing stones, waving towels and recently by detonating firecrackers. Sometimes the cranes were shot at but it was usually by outsiders, as the local people have no guns. But all these methods of protecting the crops are possible only during the day; since the cranes also feed in the fields at night, the damage to crops continues.

The number of cranes this year was large; consequently, so was the extent of crop damage. I was astonished this year, during my visit on 5 March 1987, to see ten dead Demoiselle Cranes. It was surprising that the cranes had not been carried away and eaten by the villagers. Some cranes were in a half-eaten state, and in a nearby area I found a dead kite and a dead Marsh Harrier.

I went to the neighbouring village and asked a few people there as to what could be the cause of death of these cranes. They said they did not know. However, there were small boys, around the 12 to 14 years old, who said that, during the last two days, a few cranes were seen with froth coming from their beaks, and that the deaths were due to ingestion of poison.

Among the dead birds there were two male specimens which were totally intact. It appeared that they had died not more than a few hours earlier, as their bodies had not shrunk, nor had they stiffened due to onset of Rigor mortis.

I got post mortems performed on both birds. One was an adult, the other a young bird. This proved that the birds did not die due to age. The birds weighed about 5 kg each. This proved that neither was sick, as sick birds are usually lighter in weight. The stomachs of both birds contained surprisingly large amounts (more than 2 litres) of water. This proved that the birds had become thirsty and drank a lot of water prior to death. The gizzard and stomach showed wheat grain and undifferentiated vegetable matter.

No tests were done to detect any evidence of organophosphorus in the tissue of these birds.

If the cause of death is accidental or deliberate poisoning from consumption of poisoned bait or crops sprayed with organophosphorus, it will be necessary to take steps to protect the cranes in the coming winter.

I would be interested in getting feedback on this note, particularly from naturalists who have been studying these cranes in the northern states. I would especially like to know if they had noticed similar deaths of these cranes after consuming crops sprayed with insecticides and whether there are any methods to detect organophosphorus in the dead birds.

April 7, 1987. SATTYASHEEL N. NAIK

## 13. BELLY-SOAKING AND NEST WETTING BEHAVIOUR OF REDWATTLED LAPWING, *VANELLUS INDICUS* (BODDAERT)

Belly-soaking is done mainly to transport water to the nest with eggs or young ones, and has been observed in the Charadriiformes (Maclean 1975), and I had evidence (though without personal observation) that nesting Redwattled Lapwing, *Vanellus indicus*. regularly wetted their nests from the clay pellets formed by wetting, I never had the chance to actually observe this behaviour till this year (1986). On 11 April 1986 I saw a pair sitting on the banks of a lake and drinking. Suddenly, one of them started dipping its belly repeatedly into the water, and then took off. I knew that the bird was nesting nearby and taking water to the nest, but I could not follow the bird as it flew out of view. On April 25th I discovered a nest just on the banks of the lake. This gave me the opportunity to study the belly- soaking behaviour. On April 28th I positioned my camera at a vantage point and walked towards the nest to disturb the incubating bird. The bird quietly moved away from the nest. I quickly retreated to my position and waited for it to return. Soon the bird walked to the water and started to drink, then soaked its belly 3-4 times before walking back to the nest. I quickly went to the nest to examine the eggs; they were copiously drenched with water. The belly-soaking behaviour was not seen during the early hours of the day when the temperature was low. During the early hours the incubating bird was not very anxious to return to the nest in a rush after the intruder left; while during mid-day, when the temperature was high, it returned to the nest immediately. If the intruder stayed longer the bird appeared visibly agitated and walked towards the nest, pausing and retreating. This behaviour was repeated with weak vocalization.

On May 10th I saw 3 other birds, which were obviously nesting somewhere nearby, doing belly-soaking before taking off from the lake. During that time of the year this lake is the only source of water.

The incubating bird, once relieved by its partner, goes to the water, drinks several times and starts preening for a while (15- 30 minutes) and then drinks again repeatedly. Just before taking off it does the belly-soaking 3-5 times. This observation was made several times on 4 birds.

On May 21st at about 1500 hrs I saw that two eggs had hatched. The parent birds repeatedly flew towards me noisily. As soon as I left the area one of them soaked its belly 3-4 times and went to the nest. I could clearly see through my binoculars the chicks drinking off the wet belly feathers of the parent before the parent sat to brood them.

Though belly-soaking has been reported by earlier observers (Dharmakumarsinhji 1964, Jayakar & Spurway 1965) I think that this is the first time that it has been photographed.

October 21, 1986. V. SUNDARARAMAN

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## 14. SWINHOE'S SNIPE *GALLINAGO MEGALA*: A NEW SPECIES FOR NEPAL

In the early morning of 6 March 1987, a party of birdwatchers were working an area of damp rice fields between Biratnagar and Itahari in the lowlands of south-eastern Nepal with the intention of finding Pintail Snipe *Gallinago stenura*. After finding numerous Common Snipe *G. gallinago* we eventually flushed two or three Pintail Snipe and were following them up to try and obtain views of them on the ground, when a distinctly larger snipe was silently flushed from relatively dry ground close to some wet field edge.

At this point a number of snipe, chiefly Common, but with at least two Pintail, rose and the unusual bird joined the party which circled over us at a height of some 10 m or more. The flock did a couple of circuits of the immediate vicinity, affording us as good a view as we could have wished, giving us relatively brief, but quite adequate comparative views of the three species in the air at the same time.

It was obvious from the start that the bird could only be Swinhoe's Snipe, a species that I had previously encountered on numerous occasions whilst on its breeding grounds in Siberia during five separate visits there.

The birds moved over a small river and dropped into a more extensive area of wet fields, but we were unable to follow them as a crossing point could not be found.

*Field Description*: By comparing the birds in the air together, although only Common Snipe was actually alongside the Swinhoe's, it was apparent from all angles, i.e. in profile when going around, when directly over head and when tail-on going away, that it was distinctly larger and bulkier than the Common Snipe in both the body depth and width of the wing; the bill was roughly the same length as that of the Common Snipe and was held almost horizontal, but the plumage, i.e. wing pattern above and below, was that of a Pintail Snipe. All the Pintail Snipe that we had flushed looked distinctly smaller and shorter-billed than the Common Snipe.

The body appeared rather long, although depth of breast and belly gave it a chunky appearance. Only the very tips of the toes, at most, projected a little beyond the tip of the tail—a feature that I have observed in Siberia with Swinhoe's. I concentrated on this point as I was looking out for the relatively extensive toe projection of Pintail Snipe, which is considered to be a useful aid (Marchant *et al.* 1986, Taylor 1980) for identifying Pintail Snipe, a feature that I had overlooked in my paper concerning the identification of this species (Madge 1977). Sadly, none of my views in recent years of Pintail Snipe have been quite at the right angle to see this and on this occasion I gave up the opportunity to concentrate on the Swinhoe's.

Plumage details were admittedly sparse. It had the typical snipe head pattern, the belly was unmarked and whitish, similar in extent to that of Common Snipe, and the breast was dull light brownish. The underwing was densely and uniformly barred throughout on the coverts, with no paler central areas visible as on Common Snipe. Neither the underwing or the upper wing had a trace of white trailing edge to the secondaries, which was visible on the Common Snipe in the air with it. The upper wing, seen as the bird was rising, was dull and light brown, rather uniform and not as contrastingly marked as in Common Snipe, with flight feathers not obviously darker. In short, it looked less striped on the upperparts than Common Snipe but looked very much like Pintail Snipe in pattern and coloration both from above and below.

To summarise, the bird had the upper and underwing pattern of a Pintail Snipe but was obviously larger and longer-billed. It was a little larger and bulkier than Common Snipe, with rather longer and deeper body and rather broader and slightly blunter primaries, but the bill was roughly the same length as that of Common Snipe flying alongside it. It was not as bulky as a Great Snipe *G. media* which I have seen on two occasions previously, and I consider that it was nowhere near large enough to be a Solitary Snipe *G. solitaria*, although this is a species that I have never seen. The toes projected only very slightly beyond tip of the tail but no more so than in Common Snipe, and not as extensively as is considered to be diagnostic of the Pintail. Presumably the toe projection would have been visible in the good profile views obtained as the bird circled us, especially as we were looking for this feature.

Although this is the first record for Nepal, it is not unexpected, as this species is regular in the eastern part of the Indian subcontinent in winter. The combination of features observed clearly support its identification as Swinhoe's Snipe beyond reasonable doubt.

April 2, 1987. S. C. MADGE

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## 15. ACCUMULATION OF LEAD, ZINC AND CADMIUM IN THE NESTLING FEATHERS OF HOOPOE *UPUPA EPOPS*

### INTRODUCTION

Accumulation of heavy metals in the body due to metal pollutants in food, water or air has been considered to be dangerous for the reproduction and survival of birds (Leonizo *et al.* 1986).

Due to the growing industrial activity and motor traffic, the environment is being contaminated by heavy metals. The input of lead into the environment has increased during the last two decades especially with the development of lead-containing gasolins, the consumption of storage batteries and the manufacture of lead components. The major source of airborne cadmium pollution are emissions from steel industries, waste incineration, zinc production and some agricultural practices. Monitoring of atmospheric pollution is of great importance. Bird feathers and mammalian hair, because they accumulate various metals from the environment and from food, have attracted attention for the last decade as indicators of these pollutants (Doi *et al.* 1986).

The Hoopoe (*Upupa epops*) has been declared the Punjab state bird. I have observed personally that the number of Hoopoes has decreased in recent times. This study on lead, zinc and cadmium load in the nestling feathers of Hoopoes sheds light on one of the possible causes of the decrease in population.

### MATERIAL AND METHODS

Three natural nests of the Hoopoe in the farms of Raipur Rayan village in Jullundur district, Punjab, were kept under observation during May 1986. Feathers from the chicks were taken for analysis when the chicks were 7, 21 and 35 days old. In this way, experiments were repeated thrice.

The feathers collected were rinsed thoroughly in distilled water and acetone and dried at 60°C. The feathers of each bird were weighed separately and wet-ashed in a mixture of nitric acid and sulphuric acid with a kjeldahl apparatus. Approximately 40 ml of nitric acid and exactly 1 ml of sulphuric acid were used for ashing a sample. The ashed sample solution was diluted with distilled and deionized water and adjusted to a volume of precisely 50 ml. Lead, zinc and cadmium levels were determined directly from this sample by atomic absorption spectrophotometry, and were calculated per gram of feathers. Students 't' test was employed to test the differences in levels of these elements in the feathers from different age groups of hoopoes.

### RESULTS AND DISCUSSION

The levels of lead, zinc and cadmium in the feathers from 7, 21, and 35 day old chicks are shown in Table 1. Concentrations of all three elements were observed to have increased rapidly and progressively as the chicks grew older.

TABLE 1
LEAD, ZINC AND CADMIUM IN THE NESTLING PLUMAGE OF HOOPOE

| Age of Nestling (days) | ppm/g feathers* Lead | Zinc | Cadmium |
|---|---|---|---|
| 7 | 300.00* ± 50 | 200.00 ± 20 | 100.00 ± 20 |
| 21 | 1500.00 ± 100[a] | 600.00 ± 100[a] | 400.00 ± 100[a] |
| 35 | 3000.00 ± 200[a] | 1000.00 ± 180[a] | 700.00 ± 120[a] |

*Mean ± S.E. of 3 replications;
[a] = significantly differ at $P < 0.01$ from the corresponding estimation for 7 days nestling.

The larval stages of insects (worms) are dug up by the Hoopoe from the soil of fields for feeding the nestlings. The possible food chain through which the metal pollutants reach the nestlings therefore are the larval stages of insects in the soil. The insect larvae might have accumulated these metals from the soil of fields because of the widespread use of rodenticide zinc phosphide and pesticide lead arsenite for pest management in Punjab. The source of cadmium might be the soil or air or canal water with which many farmers irrigate their fields.

The biological consequences of abnormal intracellular stores of trace elements in animal bodies are unknown. The cells have an intracellular buffer system between zinc and calcium. High zinc content lowers the intracellular calcium level by competition about binding sites (Brewer 1980). Like other trace elements zinc is essential for life but at higher concentrations it is very toxic (Mikas-Davis 1970, Petrie and Row 1977). Individuals who take excessive amounts of supplemented zinc increase their cardiovascular abnormalities (Anderson 1986). Excessive amounts of zinc in the Hoopoe nestlings thus seems to disturbs their vital organs' metabolism. The brain is most vulnerable to lead during early life periods (Stack 1986). Increased placental lead levels have been associated with higher risk of stillbirth and congenital abnormalities in women with occupational histories featuring lead (Wibberly *et al.* 1977). Bryce-Smith *et al.* (1977)

reported very much higher levels of both lead and cadmium in bones from stillbirths than in specimens from neonatal deaths. Lead exposure may affect renal function (Verschoor *et al.* 1986) and haemoglobin synthesis (Nordberg and Nordberg 1986). The delicate nestlings of Hoopoe thus very easily become victims of excessive lead because of the use of pesticides. Cadmium pollution is an increasing problem in industrializing countries. Both airborne and soil borne cadmium are potential sources for uptake into plant materials and animal bodies and affect the metabolism of vital organs such as liver, kidney and reproductive organs.

December 3, 1987. SARBJIT KAUR

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## 16. CETTI'S WARBLER, *CETTIA CETTI*, FROM HARIKE LAKE, PUNJAB

Three individuals of the Cetti's Warbler, *Cettia cetti* were caught during mist netting on 24, 25 and 29 March 1985, along the shores of Harike Lake, Punjab (32°13'N; 75°12'E.). Their biometrics were as follows (in mm):

| Wing | Bill | Tarsus | Tail |
|---|---|---|---|
| 71 | 15 | 23 | 68 |
| 60 | 15 | 21 | 59 |
| 60 | - | 29 | 58 |

The birds were trapped along the edge of the lake covered by high grass and reeds and were commonly detected by their clicking noise. They were ringed and released immediately. The HANDBOOK records its distribution as a winter visitor to the plains of the Indus (Peshawar, Bahawalpur and Sind), and possibly Baluchistan. It breeds from Iran and the Caspian Sea, east to Russian Turkestan, winters south to southern Iran and Afghanistan. The species ranges west through the Mediterranean countries to the Iberian Peninsula and Morocco (Ali and Ripley 1983). Hussain (1974) reported its occurrence from Bharatpur, Rajasthan (27°13'N; 77°32'E.), which is the easternmost record for this species. This is the second record of this bird the east of the Indus. Since three specimens were obtained from the same area its occurrence east of the Indus has now been confirmed. Moreover, it has been described as an inveterate skulker (Hussain, *op. cit.*). It is therefore possible that its occurrence in other parts of the country has been overlooked so far.

February 14, 1987.

VIBHU PRAKASH
SYED ASAD AKHTAR

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## 17. RUBYTHROAT *ERITHACUS CALLIOPE* (PALLAS) IN UDAIPUR, RAJASTHAN

Nandeshwar is a small shallow lake situated about 14 km from Udaipur. The shallow part of the lake is covered with patches of reeds and the shore with dense bushes. On 1 December 1986, while sitting near the shore, a bird alighted on the ground about 7 m from us. It looked like a female Indian Robin (*Saxicoloides fulicata*) with a faint coloration on its dorsal side. But surprisingly, it had a prominent white supercilium which was clearly visible. The bird remained for a few moments, then flew away.

Puzzled by the white supercilium we returned to the spot the next day. We combed the area for about 4 hours, and spotted two birds with white superciliums. We compared them with descriptions in the "Handbook of the Birds of India and Pakistan", Compact edition (S. Ali & S.D. Ripley), and to our astonishment they turned out to be Rubythroats.

On 18 December 1986, at around 0930 hrs we again sighted a Rubythroat in the Panchwati area of Udaipur. Panchwati is close to a *nullah* which carries overflow waters from the lakes of Udaipur, and in places it is surounded by thick vegetation. This time we saw it at very close quarters, and for over half an hour. There were *phalsa*, fig and *ber* trees growing closely together, and thick underbrush of lantana and similar bushes. The bird was seen running in short spurts after insects, fluttering its wings after each stop. Suddenly two Redvented Bulbuls (*Pycnonotus cafer*) appeared and persistently chased the bird from bush to bush till it disappeared from view. This behaviour of the bulbuls was possibly due to competition for food between them or due to the presence of a strange bird in their territory.

On 14 January 1987 we saw the Rubythroat near Pichola Lake of Udaipur City. It is perhaps the first sighting of the Rubythroat anywhere in Rajasthan apart from Keoladeo Ghana National Park, Bharatpur.

RAZA TEHSIN
January 20, 1987. MANOJ KULSHRESHTHA

## 18. STREAKEYED PIED WAGTAIL, *MOTACILLA ALBA OCULARIS* SWINHOE FROM HARIKE LAKE, PUNJAB

A specimen of the Streakeyed Pied Wagtail, *Motacilla alba ocularis*, was caught during mist netting on 31 March 1985, along the shores of Harike Lake bordering the districts of Amritsar, Ferozepur and Kapurthala, Punjab(31°12'N, 75°12'E).

The lake is dotted with numerous reed covered islands. There is intensive agricultural activity all around the lake, with some of the fields extending right upto the edge of the lake. The main crop is Wheat, *Triticum sativum* Lam., Sugarcane, *Saccharum officinarum* Linn, and Bengal Gram, *Cicer arietinum* Linn.

The bird was trapped along the edge of the lake which was covered by high grass and reeds (*Trypha* spp.) and was readily distinguished from the other Pied Wagtails by the very prominent black streak through its eyes, the measurements were as follows:

Wing: 89 mm, Bill: 13 mm,
Tarsus: 24 mm, Tail:88 mm

The dark eye streak is present in all plumages (Ali and Ripley 1983). The bird was undergoing an active body moult. It was ringed (Ring No. A-190982) and released. Subsequently two more individuals of this subspecies were observed in the area. Described as an uncommon winter visitor to Assam, Nagaland, Manipur, Bangladesh and west to central Nepal (rare); it affects dry river beds, streams, ponds, roads and cultivation (Ali and Ripley, *op. cit*). It breeds in Siberia from the Yenisey to Chuckchi Peninsula and winters in southeastern Asia and has been noted as common on passage in the Nepal valley in March, April and October (Ali and Ripley, *op. cit*). Hence its occurrence in Harike is the westernmost record of this subspecies.

SYED ASAD AKHTAR
April 22, 1987. VIBHU PRAKASH

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## 19. HOUSE SPARROWS (*PASSER DOMESTICUS* LINN.) AS PREDATORS OF ARMY WORM *MYTHIMNA SEPARATA* (WALKER) INFESTING WHEAT AT LUDHIANA (PUNJAB)

A good stand of wheat of var. PBW 52 with a row of eucalyptus and poplar on a footpath at the eastern edge of the field had an outbreak of army worm, (*Mythimna separata* (Walker), especially in the shady part of the late sown wheat cultivar which was harvested by mid May. The whole field was seen covered with faecal pellets of the larvae on the ground. There was a good population of the larvae feeding on the wheat ears, especially awns.

On 23 April 1984, at about 1000 hrs, flocks of house sparrows (*Passer domesticus* Linn.) were observed flying to and fro between the wheat fields and the eucalyptus/poplar plantation. It was thought that the sparrows were feeding on wheat ears, as they are reported to be pests of wheat (Anonymous 1986). However, on critical examination, it was found that each sparrow was carrying a single larva in its beak, with the larva held almost in the centre. This observation was confirmed many times in the same field during the same month. Sparrows are already recorded as being insectivorous, feeding on *Heliothis armigera* infesting *Dolichos lablab* (Verghese and Subramanya 1985), and on peach leaf curl aphid (Mann 1987). According to available literature, it appeared to be a new record of sparrow feeding on the army worm.

Information on sparrows in insect suppression in an agroecosystem is meagre and therefore these birds are not recognised as bioagents in biological control projects/programmes. More and effectively planned research is needed to ascertain the role of birds in suppression of particular insect species.

ACKNOWLEDGEMENT

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May 6, 1987.

J.S. BHALLA
G.S. MANN

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## 20. SOUTHERN WINTERING RANGE OF SOME WATERBIRDS

The wetlands of Pondicherry region harbour important populations of waterbirds. The region also provided, during the 1986-87 winter, some interesting bird records. We have considered only those species which showed a regular presence throughout the winter, and which therefore cannot be regarded as occassional sightings of stray individuals. The earliest and latest dates on which each species was seen are shown after its name.

Two important tanks are located in the area studied:

- Ousteri, 10 km west of Pondicherry and approximately 8 sq.km in area, is an artificial, temporary freshwater tank.
- Kaliveli, 20 km north of Pondicherry in South Arcot district of Tamil Nadu and approximately 75 sq.km, is a natural lake connected with the Bay of Bengal by a narrow channel. Its water turns brackish after the withdrawal of the north-east monsoon; the lake dries up in summer.

**White Stork** ( *Ciconia ciconia* ) : 11 Nov - 14 April

The wintering ground of this species is not clear, and a specific appeal for sightings was launched last winter by the B.N.H.S. (*Hornbill 1985(3)*: 40). It gave mainly qualitative results, but no clue to important concentrations (Serrao 1986). This stork is also said to be less common in south India than in the north (Ali & Ripley 1983 : 25). Nevertheless, Johnson (1984) has recorded one flock of over 360 birds in Tamil Nadu; however, it has not been observed whether this large concentration wintered there.

Over 300 birds of this species have been wintering in Kaliveli and Ousteri, the highest number recorded being 340. Eighty were already present by mid-November, when the lakes started filling, and 140 remained up to 10th April. Even on the occasions when more than 100 birds could be very accurately identified, not even a single individual of the eastern subspecies *C. c. boyciana* could be observed.

**Greater Spotted Eagle** (*Aquila clanga*) **: 25 Nov – 18 March.**

It is regarded that this species has not been reported recently from the Malabar and Carnatic coasts, where it used to be common. One specimen taken in North Karnataka ♀ 1941 was perhaps the latest southern record of this species (Ali & Ripley 1983 : 70). Three Greater Spotted Eagles spent the 1986-87 winter in Kaliveli. Various close sights of the birds through a spotting scope, both in flight and on the ground, allowed us to establish definitely the specific identity of the birds, which included at least one adult and one juvenile.

**Common Pochard** (*Aythya ferina*) and **Tufted Duck** (*A. fuligula*) : 19 Nov – 14 Jan & 19 Nov – 18 Feb.

Both these ducks are known to be rare or irregular in south India, down to Karnataka, where, however, the former is not uncommon in some years (Ali & Ripley, 1983 : 46-47). They do not seem to have been recorded from Point Calimere (Sugathan 1982). These two species wintered in large numbers in Ousteri tank, the maximum count being 600 for the former and 800 for the latter.

**Ruddy Shelduck** (*Tadorna ferruginea*) : 25 Nov – 28 Feb.

The same applies to this species, which wintered in Kaliveli in smaller numbers (upto 30). This seems to be a regular feature (Pieter, *pers. comm.*)

**Blacktailed Godwit** (*Limosa limosa*): 18 Dec – 25 March.

It is now well established that this wader is no longer rare in the South: it is common in Point Calimere (Sugathan 1982), and in Sri Lanka (Hoffmann 1982). Our study provides further evidence that the species is now common in the south, with flocks numbering up to 90.

### DISCUSSION

The above records show a southward extension of the wintering range of some species. But how regular is this distribution?

Previous observations by Pieter (*pers. com.*) seem to indicate a regular presence of White Storks, though in lesser numbers, of Ruddy Shelduck and perhaps of Spotted Eagle. In addition, it is quite possible that the local conditions in some traditional wintering places (droughts in Bharatpur, for example) may sometimes force some species to winter further south than usual (V S Vijayan, *pers. comm.*). The episodic abundance of the Redcrested Pochard (*Netta rufina*) in south India is already known (Ali & Ripley 1983 : 45), and might be due to such reasons. This species wintered in Kaliveli (upto 110), and the winter distribution of other species might follow the same pattern.

A recent extension of the wintering range cannot be ruled out for some species, as it now seems established for the Blacktailed Godwit. Finally, due to the lack of observers and of spotting scopes, some species may have remained under-recorded in south India up to now.

Further observations in the years to come are necessary before definitely concluding on the status of these species in the south. But the regular presence during one complete winter of a huge flock of White Storks, of Greater Spotted Eagles thought to have completely disappeared from South India due to "altering ecological conditions" (Ali & Ripley 1983 : 70), and the abundance of more common waterbirds (tens of thousands), are a clear indication of Kaliveli and Ousteri having a rich ecological potential. It might be found that several species reach there their southernmost winter limit.

April 28, 1987. C. PERENNOU

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## 21. TWINNING ABNORMALITY IN *GAVIALIS GANGETICUS* (REPTILIA, CROCODILIA)

Singh and Tandan (1978) and Subba Rao and Bustard (1979) have recorded congenital blindness in *Gavialis gangeticus*. Besides blindness, eleven other developmental abnormalities have been recorded for the species by Singh and Bustard (1982). In the present note we put on record the occurrence of twinning abnormality that has not been reported earlier.

## OBSERVATIONS

A captive breeding population of gharial is maintained under simulated natural conditions in the Nandan Kanan Biological Park, Orissa. During the 1986 season five nests were made in the breeding pen. Out of 33 eggs laid on 23 March 1986 in one nest, 17 were shifted from the pen for hatchery incubation. Two of the shifted eggs were infertile, while the other 15 eggs produced live hatchlings. From one of these eggs one live and one dead hatchling were recovered. These measured and weighed 34.2 cm, 78 g and 25.8 cm, 30 g respectively. The small and dead hatchling was fully developed, with snout-vent length of 13.4 cm and tail 12.4 cm long.

Other known types of twinning abnormalities in *Gavialis gangeticus* are: a double-yolked egg in a wild-laid nest of 51 eggs from river Chambal (1981, unpublished data) and twin hatchlings of the same pattern as stated earlier in the above except that here both the young ones were dead (D. Basu, *pers. comm.* 1982). Further details on these are not available.

## DISCUSSION

Ferguson (1985) has catalogued three types of twinning in Crocodilians: double yolks, twins and axial bifurcation causing partial twinning.

The twins recorded at Nandan Kanan correspond to stage 28 (Ferguson 1985) in *A. mississippiensis*. Similar to our record, full term hatchling twins have been reported only for *O. tetraspis* (Tryon 1980) and *C. niloticus* (Hutton and Loveridge, *pers. comm.* in Ferguson 1985). Out of the two hatchlings at Nandan Kanan, the large live one is comparable to a normal hatchling (Singh 1978). The small dead hatchling, however, is smaller by almost a quarter in length and relatively lighter in weight. Also, unlike the normal condition, the smaller hatchling had a relatively smaller tail length. Double-yolked eggs and the eggs producing two developing young are less than double the size and weight of normal size eggs. Therefore, the twins may be registering some competition to attain normal hatchling size. The reason why one hatchling grows larger may depend on its orientation inside the egg and perhaps is an end result of a complex system of competition. Singh (1978) states that the proportion of different regions of the body are determined through 'egg-space economy' and the 'hatching-time significance' of a corresponding region. Both these phenomena are also expected to be in operation within a 'twin-egg'. It is presumed that, if one of the twins has a positive edge in development, it attains the normal size, while the other hatchling grows so as to be accommodated in the remaining space. This appears to be further supported by the proportionately smaller tail length in the smaller twin; as per Singh's (1978) hypothesis the tail grows in the distal region to a length to 'utilise' the space available inside the egg (and of course bears a survival value for the hatchlings upon hatching).

Double-yolked eggs have been reported to have occurred in *C. acutus* (Neill 1971), *C. noiloticus* (Blomberg 1979), *A. mississippiensis* (Ferguson and Joanen 1983) and *C. porosus* (Webb *et al.* 1983). Double-yolked eggs in *A. mississippiensis* are stated to be laid first or last by young females (Ferguson and Joanen 1983). If it is to be believed as a general principle, a double-yolked condition in a clutch of 51 eggs in *Gavialis gangeticus* could be a freak. Such a clutch is the characteristic of gharials in their latter half of breeding age.

## ACKNOWLEDGEMENTS

We express our gratitude to the Forest Departments of Orissa and Madhya Pradesh and to the CRC of Wildlife Institute of India for the facilities provided during the period the observations were recorded and the note prepared. We thank Sri D. Basu for the information.

L. N. ACHARJYO
May 12, 1987. L. A. K. SINGH

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## 22. OBSERVATIONS ON STRANDED GREEN TURTLES, *CHELONIA MYDAS*, IN THE GULF OF KUTCH

Although the green turtle, *Chelonia mydas* (Linn.), has been reported from the Gulf of Kutch by Bhaskar (1978), little has been recorded about the biology of this population. This note reports a few observations on stranded individuals from this area in the hope that this may stimulate further, more detailed study.

On 5 January 1987 a female (JGF 5135) was found dead on the east side of Bet Dwarka Island, south of Hanuman Point (approx. 69° 8' 48" E, 25° 27' 48" N), about 7.5 km east of Okha. Standard measurements (in cm) include: curved carapace length (CCL) = 100; curved carapace width (CCW) = 92; straight carapace width (SCW) = 69; plastron length (PL) = 76; supracaudal notch (SCN) = 0.0; and head width (HW) = 13.5. Scalation was normal: *viz.* 5 vertebrals; 4 left/4 right pleurals; 11/11 marginals; 1/1 supracaudals; 1 cervical; 4/4 postoculars; intergular moderate; 6 pairs of plastral scutes (gular through anal); and 4/4 inframarginals. There was no sign of injury, but a copulation notch was conspicuous on each 'shoulder': large on the right and moderate on the left.

The left ovary had: approximately 60 yellow follicles about 15 mm in diameter; about 15 grey follicles of irregular shape and size; at least 60 *corpus lutea*; at least 100 *corpus albicantia* (or very small ova); and 3 large 'watery' follicles. There was no sign of enlarged yellow follicles or of oviducal eggs.

Total contents of the stomach weighed 5 kg. A subsample revealed 4 dominant species of algae; in order of importance they were: *Caulerpa scalpelliformis*, *Gelidiella acerosa*, *Ulva lactuca*, and *Laurencia pedicularoides*. Nine other algae occurred as incidental components: *Champia indica*, *Caladophora glomerata*, *Dictyopteris australis*, *Dictyota dichotoma*, *Halymenia venusta*, *Hypnea musciformis*, *Myriogloea* sp., *Soleiria robusta* and *Spatoglossum variabile*. *Caulerpa scalpelliformis* constituted 60 to 70% of the total by volume (identifications by Dr M S Murthy). (G. Balazs [*in litt.*, 5 Dec. 1988] points out that *Gelidiella acerosa* may be confused - by turtles as well as by people - with *Pterocladia capillacea*.)

Epizoa on the carapace were diverse: green and red-brown filamentous algae; calcarious red algae; cocoons of *Ozobranchus* sp. (leech); and at least three species of barnacle - *Chelonibia testudinaria*; *Platylepas hexastylos*; and one unidentified.

On 10 January 1987 the carapace of a *Chelonia mydas* (JGF 5138a) was found behind the ravaged mangroves on the mainland at Ashapura Point, about 20 km southeast of Okha. Standard measurements (in cm) include: CCL = 94; CCW = 83; SCW = 70; PL = 75; SCN = 0.0. Scalation was normal except for some asymmetry in the 4th vertebral and in 2 marginals. The soft tissues had virtually disappeared, but there were some shreds of muscle still clinging to the inside of the shell. No epizoa were seen. There was no sign of the cause of death.

As both carcasses were near the mouth of the Gulf, and strong tidal currents run there, it is not possible to determine whether or not these animals had died inside or outside the Gulf. However, *C. mydas* are commonly seen further inside the Gulf, where there appear to be both nesting and feeding populations (Bhaskar 1978; T. Mundkur, *pers. comm.*). In this respect, it may be relevant that a group ('flotilla') of at least 20 turtles was seen at Okha, at the southern mouth of the Gulf, on 11 March 1987; they were apparently surfacing and moving together (T. Mundkur, *pers. comm.*).

Little can be said about specimen JGF 5138a. Its shell measurements are each a few cm below the respective means for females nesting at nearby Hawksbay, Pakistan, but the values are well within the ranges for this population (Kabraji and Firdous 1984:18).

Specimen JGF 5135 was clearly a female that had recently ovulated. Nesting (evidently by *Chelonia*) occurs on Bet Dwarka, Samini, and nearby mainland beaches (Mundkur *in litt.*, 26 Nov. 1988), as well as on Bhaider Island (Bhaskar 1978; T. Mundkur, *pers. comm.*), about 15 km east, further inside the Gulf. The oceanic beach at Mithapur, some 20 km west and then southwest of where the carcass was found, is also an area of significant nesting (S. Trivedi, *pers. comm.*). Unfortunately, next to nothing is documented about these nesting areas, but the peak in egg laying is said to be around the end of the year at Mithapur (S. Trivedi, *pers. comm.*). *Chelonia mydas* is also reported to nest all along the northern coast of the Gulf of Kutch, notably from September to November (Himmatsinhji *in litt.*, 9 Jan. 1987).

A major nesting population of *Chelonia mydas* has been studied at Hawksbay, Karachi, Pakistan, for nearly a decade (Kabraji and Firdous 1984). Nesting occurs round the year, with a peak in numbers during November, and it has been suggested that 6,000 females nest here in a year. This beach is about 350 km northwest of Bet Dwarka, and although it is much farther away than are the sites in or near the Gulf, the fact that a very large number of *C. mydas* nests there makes Hawksbay a likely source of turtles for the Gulf of Kutch.

Nonetheless, the only way to confirm the source of the Kutch turtles is through recaptures of tagged individuals. The project at Hawksbay, run by the Sind Wildlife Management Board, has to date applied over 1,000 tags to turtles (Kabraji *in litt.*, 17 July 1988), but as yet there is no report of a long-distance recovery. (There do appear to be major problems with tag loss at Hawksbay [pers. obs.], which would greatly reduce the chances of international tag returns).

If the animals nesting in, or adjacent to, the Gulf of Kutch, and/or at Hawksbay are feeding in the Gulf of Kutch, this would be an example of a *C. mydas* population that is virtually non-migratory, or that migrates a very short distance. This phenomenon is not thought to be common in this species, although there is an indication that a population off the coast of Zanzibar, Tanzania, may be non-migratory (Frazier 1981).

The algivorous feeding habit of JGF 5135 is remarkable, but consistent with additional evidence from Pakistan. Kabraji and Firdous (1984:23) recounted reports of divers in the Karachi area watching (and hearing!) *Chelonia* feed on algae attached to rocks. A male *C. mydas* found dead on the Hawksbay beach on 16 June 1986, apparently subadult (CCL = 88.0; CCW = 80.5;), had its stomach packed with bright red filamentous algae (pers. obs.).

The fact that there are dugongs in the Gulf of Kutch, and that a dugong stomach from there was full of *Halophila ovalis* (Frazier and Mundkur in prep.), indicates that significant pastures of at least a small marine angiosperm are present in the Gulf. Perhaps the larger angiosperm species, or 'seagrasses', favoured by turtles (e.g. Hydrocartiaceae and Potamogaliceae: *Cymodocea* spp., *Syringodium isoetifolium*, *Thalassia hemprichii*, and *Thalassodendron ciliata*) do not form significant pastures in this area, and for this reason the turtles specialize on algae, which are abundant in the Gulf (Murthy *et al.* 1978, Murthy, *pers. comm.*; pers. obs.). In addition, it is generally thought that algae may provide more nutrition for *C. mydas* than do marine angiosperms (Bjorndal 1982; *in litt.*, 22 July 1988). (However, Balazs [*in litt.*, 5 Dec. 1988] finds that *Halophila ovalis* [hawaiiana] is prominent in the diet of *C. mydas* in the Hawaiian region).

It is remarkable that two *Chelonia* were found dead in the Bet Dwarka area within a short period of time, relatively close to each other. In neither case could the cause of death be determined, but the fact that there were no external injuries and that the two animals had succumbed apparently in the same area at about the same time suggests that they had been drowned in trawls working in the Okha area. There is active trawling in this area, and drowning in trawl nets is a major cause of mortality of sea turtles; nearly 12,000 turtles may be drowned each year off the eastern coast of USA (Gordon and Fletemeyer 1984:3-467; Crouse 1982, 1984).

However, there are other probable causes of death by human agencies. The remains of an adult-sized *Chelonia* was found near the Vadinar oil terminus near Jamnagar. It had been cut in half transversely behind the front flippers; a ship's propeller was therefore thought to be responsible (Mundkur *in litt.*, 17 March 1987). Large numbers of *Chelonia mydas* wash up dead at Hawksbay, Karachi, from unknown causes; this area is adjacent to a major port with very active ship movement and heavy contamination (pers. obs.).

There is an obvious and pressing need for detailed studies of the Gulf of Kutch, for tagging activities on the Mithapur and Kutch beaches, and for active campaigns to alert local fishermen of the tagging programmes and of the rewards offered for turning in tags. In addition, incidental causes of mortality of turtles should be assessed and reduced as much as possible.

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December 18, 1988. J. FRAZIER

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## 23. MORPHOMETRY OF THE INDIAN FLAPSHELL TURTLE (*LISSEMYS PUNCTATA ANDERSONI*)

Morphometry of the Indian flap-shell has already been described by Smith (1933), Pritchard (1979) and Daniel (1983). The present note contains some additional information based on studies on specimens from the Keoladeo National Park, Bharatpur, Rajasthan, India.

The presence of seven callosities in the plastron is one of the main characteristic features of flap-shells. However, about 5% (34 out of 740 examined) of the turtles in this Park had only six callosities. The one missing was the singular entoplastral callosity and was recorded in smaller individuals with a carapace length (CL) less than 130 mm. Only in 8 cases was it observed in specimens above 130 mm. Flapshell turtles without an entoplastral callosity have also been reported in the past from Rajasthan (Biswas and Sanyal 1977). The size of this callosity seems to bear a relationship to the age and size of the turtle.

Earlier records show that the maximum known carapace length and weight of this species are 275 mm and 4.5 kg respectively. In Keoladeo National Park, instances of carapace length (curvature measurement) exceeding 280 mm were fairly common (25 out of 740 examined) and the maximum recorded length was 350 mm. The highest recorded weight in this Park was 5.2 kg in summer. This particular specimen was a female and had no signs of developed eggs when examined by probing the inguinal area.

The flap-shell turtle has two pairs of external glands as given by Smith (1933). One pair opens on the lower side of both hyo- hypo callosities of the plastron which is exactly above the cutaneous femoral valve. The other pair opens on either side of the anterior part of the carapace, just above the midline of the forelimb cavity (humeral). The presence of the latter was not mentioned by Auffenberg (1981) while describing the glands of this species. These glands secrete an odorous yellow fluid which, presumably has a defence function, averting the attack of predators at least for a short duration.

I am thankful to Dr. V. S. Vijayan, Project Scientist, BNHS Ecological Research Centre, Bharatpur for encouragement and to Mr U. Sridharan.

December 31, 1988 S. BHUPATHY

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## 24. NEW LOCALITY RECORD FOR THE INDIAN PINKRINGED TERRAPIN

In July 1988, during my visit to the Patalia Hanuman, on the outskirts of Surat city (21°12' N, 72°52' E) on the bank of the river Tapti and where the river meets the Gulf of Cambay and forms an estuary, I saw a freshwater turtle basking on the dry mudflats, about 3 m away from the river. I captured the turtle and it was identified as an Indian Pinkringed terrapin, *Kachuga tentoria circumdata*. The description and other details are given below.

*Measurements & Weight:* Carapace length 96.0 mm, carapace width 81.0 mm, plastron length 71.9 mm, body height 43.3 mm and weight 85.0 g.

*Description:* Carapace olive brown with a light pink ring around pleuro marginal junction. Carapace elevated with flat sides and a strong median keel, with third vertebral shields longer than the second. Dorso-median keel pink with black border. Plastron yellow with large black blotches on each scute. Head olive-brown with a pink broken band on the occipital region and a pink postocular spot. A smaller pink mark located at dorsal posterior edge of the eye. Neck with indistinct stripes, limbs olive with uncleared spots. Dark olive and cream coloured vertical stripes on rump region.

According to the literature *K. tentoria* occurs in the Mahanadi and Godavari rivers and probably the Krishna river system (Smith 1933). According to Moll (1987), 3 subspecies of the Indian Tent Terrapin *K. tentoria* are recognized: *K.t. tentoria* in the rivers of peninsular India, *K.t. flaviventer* in the eastern Ganges and its northern tributaries and *K.t. circumdata* in western and central drainage of the Ganges river.

The present record of the Pinkringed Terrapin *K.t. circumdata* from river Tapti near Surat district, Gujarat, considerably extends the range of the species.

I am thankful to Mr Raju Vyas, Zoo Inspector of the Sayaji Baug Zoo, Baroda, for identification and suggestions.

December 9,1988. KARMVIR BHATT

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## 25. A PECULIAR FOOD HABIT OF THE GARDEN LIZARD *CALOTES VERSICOLOR* (DAUDIN)

The report by Sekar (1988), where he mentions that buds of *Tabarnae montana* were fed upon by a garden lizard *Calotes versicolor* (Daudin), prompted us to add the following information on the vegetarian food habits of the reptile. We had a small kitchen garden at our residence in Malaparamba in Calicut and during two occasions we observed a medium sized garden lizard chewing the tender succulent shoots of cowpea (*Vigna sinensis*); however, it never attempted to swallow the chewed plant material. Since we observed this type of behaviour during the afternoons of hot summer months (April/May) we presume that the garden lizard was attempting to derive some moisture from the plant tissue rather than utilising it as a food material.

S. DEVASAHAYAM
January 3, 1989. ANITA DEVASAHAYAM

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## 26. NEW EVIDENCE OF THE OCCURRENCE OF WATER MONITOR (*VARANUS SALVATOR*) IN MEGHALAYA

The distribution of the Water Monitor (*Varanus salvator*) in the western parts of its range is enigmatic. This otherwise adaptable species is to be found mainly in the coastal areas of Orissa, in the deltas of Brahmini-Baitarini, the Sunderbans of West Bengal and Bangladesh; Sri Lanka, and on many of the islands in the Andaman and Nicobar archipelago (reviewed by Whitaker and Whitaker 1980, distribution maps in Das 1980). The lizard is absent along the rest of the eastern coast of India and the distribution, in general, in the region appears similar to that of the Saltwater Crocodile (*Crocodylus porosus*). The reason for the absence of both species in Andhra Pradesh and Tamil Nadu appears to be a result of hunting, and the destruction of their mangrove habitats. Fairly large populations of *V. salvator* do, however, still occur in several pockets south of Calcutta city which were once dominated by mangroves, and Finn (1929) wrote that a large specimen used to frequent Calcutta's Zoological Gardens (at Alipore) in the 1890's.

*Varanus salvator*, however, has also been reported from regions in India far from the coast. Anderson (1872) reported that the species was not uncommon in Assam. Smith (1935) included the eastern Himalayas in the distribution of the species, but listed no specific localities. Auffenburg (1986) stated that the species occured in Assam.

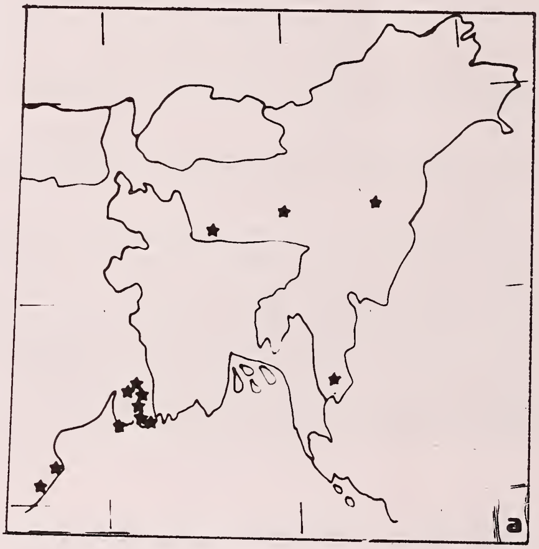
The Zoological Survey of India has a specimen (ZSI 2155) from Samagooting in the Naga hills, Nagaland. The occurrence of *V. salvator* in the northeastern states of Meghalaya (from Simsang, in the East Garo hills) and Mizoram (Kolodyne river in the Lushai hills) was reported by Parry (1932). Three years later, Smith (1935 : 400) was apparently less sure of the Garo Hills record but did include northeastern India in the distribution of the species. The only locality in northern Bangladesh from where *V. salvator* has been collected is Rangpore (ZSI 2126). The present communication is based on recent evidence found by the author of *V. salvator* in the Khasi and Garo hills, Meghalaya.

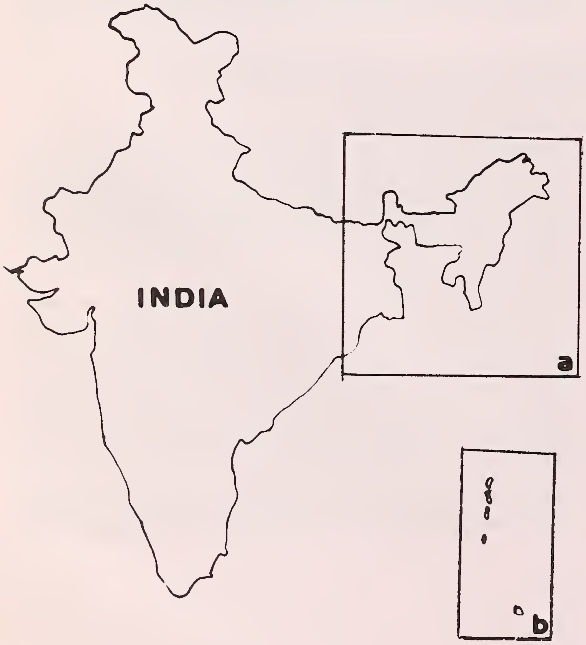
An adult *V. salvator* was collected by Mr. H. Malngiang, Wildlife Range Officer, Nongpoh, from near Borhulong in the Nongkhyllem Wildlife Sanctuary, East Khasi Hills district, in the second week of March 1988. The specimen, which has a total length of 168.5 cm, was verified by me at the museum of Lady Hydari Park, Shillong. The monitor, one of two which were run over by a jeep on the forest road while apparently attempting to mate, proved to be a male on skinning, and had the remains of fishes and crabs in its gut (Malngiang, *pers. comm.*).

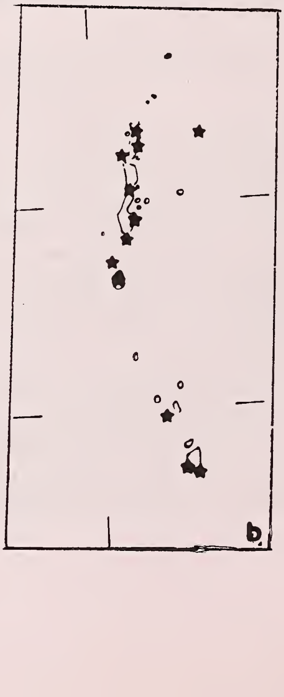
In the afternoon of 15 June 1988, while conducting field work in the Nongkhyllem Reserve Forest, I saw a juvenile *V. salvator*, with a total length under a metre, basking on a branch overhanging Umling stream, on the Nongpoh-Lailad road. The bright yellow rings on a dark skin, diagnostic of the species, were distinctive. The only varanid reported from the Nongkhyllem Wildlife Sanctuary is the yellow monitor (*Varanus flavescens*) by Das Choudhury (1982).

At the Tura Zoological Gardens, a single fairly large *Varanus salvator* was seen, with a total length of 1.5 m. It was reportedly collected from the forests around the town of Tura in the West Garo hills. The present findings therefore confirm the occurrence of *V. salvator* from the Garo hills, and indicate its presence in the Khasi hills.

Funding for field work was provided by the IUCN/WWF (Project 6343: Land tortoises in northeastern India) while WWF-I (Eastern Region) provided administrative help. I thank officials and field staff of the Meghalaya Forest Department, in particular Mr. V.K.







Nautiyal, Conservator of Forests, Wildlife Circle, Mr. A. Lyngdoh, Divisional Forest Officer, Khasi and Jaintia Hills Wildlife Division, Mr P.H.S. Bonney, Divisional Forest Officer, East and West Garo Hills Wildlife Division, and Mr. H. Malngiang, Wildlife Range Officer, Nongpoh, for permission and facilities to conduct field work. The Director, Zoological Survey of India and Officer-in-Charge, Reptilia Section, ZSI, allowed me to examine their *Varanus* material. Romulus Whitaker critically read an earlier draft of the manuscript.

October 5, 1988. INDRANEIL DAS

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## 27. RANGE EXTENSION OF THE PAINTED BRONZEBACK TREE SNAKE *DENDRELAPHIS PICTUS* (GMELIN)

The Painted Bronzeback Tree Snake *Dendrelaphis pictus* has been recorded from the whole of the Indo-Chinese region, from Bengal and the eastern Himalayas to southern China. It is common in many places in its range, and is found both in the hills and in the plains (Wall 1910, Smith 1943, Daniel 1983). This snake appears not to have been recorded from Nepal. In fact even the commoner Indian Bronzeback Tree Snake *D. tristis* was only recently recorded from Nepal (Flemming and Flemming 1973).

On 13 March 1988, while studying the Bengal Florican *Houbaropsis bengalensis* at the Dudwa National Park (28° 24'—28°27' N, 80°31'—80°52' E), Lakhimpur Kheri district, Uttar Pradesh, I came across one Painted Bronzeback Tree Snake at the Navalkhad Phanta. The snake was seen on the ground at the base of a clump of grass about 50 to 70 m from the nearest tree and at least 500 m from the forest.

Several pictures were taken as it could not be identified beyond the generic level. On comparing the pictures with descriptions in 'Fauna of British India' (Smith 1943) and 'Book of Indian Reptiles' (Daniel 1983) it was unmistakeably identified as being a *Dendrelaphis pictus*. The main distinguishing characters were a yellowish flank stripe demarcated sharply above and below by dark (or black) stripes, a dorsal bronze coloured stripe along the vertebral column and a white belly.

The presence of the Painted Bronzeback Tree Snake in Dudwa is an extention of its range much further west than earlier reported.

### ACKNOWLEDGEMENTS

This observation was made while studying the Bengal Florican under the Endangered Species Project of the B.N.H.S, which is sponsored by the Department of Environment and funded by the U.S. Fish and Wildlife Service. I thank Mr J. C. Daniel, Mr. I. D. Kehimkar, Mr. Carl D'Silva and Mr. Aloysius Gnanasekar of the BNHS for help in confirming the identification of the snake.

January 3, 1989.. RAVI SANKARAN

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## 28. SOME MORE SPECIES OF ANURANS FROM DHARWAD, NORTH KARNATAKA

This note on Anurans from areas of Dharwad in north Karnataka is intended to add to the list of Indian species of Anura, as tabulated by Inger and Dutta (1987). Collections of frogs and toads were made from areas of Dharwad and adjoining places in north Karnataka, mainly in order to study the occurrence of the two most interesting forms of commensal opalinid ciliate protozoa, *Protoopalina* and *Zelleriella*, in Indian Anura. These collections were made by the present writer from 1944 to 1948, and later by Miss Lucy Lobo in 1956 and 1959. The host frogs examined for the protozoological investigation were identified by Dr. L.S. Ramaswamy of the Mysore University and some by the Zoological Survey of India at Calcutta. All the frog samples are deposited in the Karnataka College (Department of Zoology) Museum at Dharwad.

Except Pelobatidae, which are confined to the north-eastern region of India, the remaining 4 families: Bufonidae, Microhylidae, Ranidae and Rhacophoridae, are well represented in north Karnataka. The faunal lists presented above include a total number of 19 species belonging to 9 genera, of which the two species of Rana, namely *Tomopterna rufescens* and *Rana keralensis*, are examples of very rare occurrence that need inclusion in the main list of India species. In addition to these two, 6 other species: *Micrixalus saxicola*, *Micrixalus opisthorhodus*, *Rana leptodactyla*, *Rana malabarica*, *Tomopterna breviceps*, and *Bufo beddomii*, which are omitted by Inger and Dutta (1987), should be considered for inclusion under this group. Only 3 species of frogs, namely *Rhacophorus*, and *Philautus* were not determined.

The Anuran surveys undoubtedly are still considered incomplete, and any additional collection, observation or resurvey would certainly be greeted with complacency in a vast country like ours. By no means are the interrelationships and the course of evolution of the Anuran families, genera and species fully understood. Paleontological data for Anura is very scant; in addition, the groups themselves are so unrelated that linking one with the others becomes extremely difficult.

However, certain indications as to the probable phylogeny have been gathered by using concomitantly data on frog organisms or the commensal opalinids such as (1) *Protoopalina* (binucleated but elongated in form), (2) *Zelleriella* (binucleated but flattened in form), (3) *Cepedea* (multinucleated but elongated) and (4) *Opalina* (multi- nucleated but flattened) to trace the course of evolution and migratory routes which both the frog host and its opalinid commensal have traversed during geological times towards the eastward and westward directions of the earth (Metcalf 1940).

I. List of frogs and toads studied during
1944 – 1948 (Uttangi)

| | Host | Locality |
|---|---|---|
| 1. | *Bufo melanostictus* | Dharwad |
| 2. | *Microphyla ornata* * | Naglavi |
| 3. | *Micrixalus opisthorhodus* | Dharwad |
| 4. | *Micrixalus saxicola* | Dharwad |
| 5. | *Uperodon systoma* | Dharwad |
| 6. | *Rana tigerina* | Widespread |
| 7. | *Rana leptodactyla* | Dharwad |
| 8. | *Rana temporalis* | Dharwad |
| 9. | *Rana limnocharis* * | Dharwad |
| 10. | *Tomopterna breviceps* * | Dharwad |
| 11. | *Rana malabarica* * | Yellapur |
| 12. | *Rana keralensis* | Dandeli |
| 13. | *Philautus* sp.* | Castlerock |
| 14. | *Rana cyanophlyctis* | Widespread |

II. List of frogs and toads studied during
1956-1959 (Lucy Lobo)

| | Host | Locality |
|---|---|---|
| 1. | *Bufo melanostictus* | Widespread |
| 2. | *Bufo beddomii* | Castlerock |
| 3. | *Microhyla ornata* * | Anmode |
| 4. | *Tomopterna breviceps* * | Londa |
| 5. | *Rana keralensis* | Dharwad |
| 6. | *Rana curtipes* | Anmode |
| 7. | *Rana cyanophlyctis* | Dharwad |
| 8. | *Rana limnocharis* | Dandeli |
| 9. | *Tomopterna rufescens* | Castlerock |
| 10 | *Rana malabarica* | Londa |
| 11. | *Rana tigerina* | Widespread |
| 12 | *Philautus* sp. | Castlerock |
| 13. | *Rhacophorus* sp. | Castlerock |
| 14. | *Philautus* sp. | Anmode |
| 15. | *Kaloula pulchra* | Londa |

* indicates presence of binucleated opalinid genera *Protoopalina* and *Zelleriella* on the frog host.

For example, the occurrence of protoopalina group II of Metcalf in both Discoglossid and Pelobatid toads suggests their origin and spread as being somewhat parallel. Both of them evolved in India (Himalayan highlands) at a time when Australia had separated from Asia. The point of interest is that the Discoglossid protoopalina group II of Metcalf are still found in South India (Uttangi 1951 and 1961) although the Discoglossids themselves are gone. The Discoglossids have not been in contact with *Zelleriella*. The adoption of protoopalina (II) by the south Indian frogs (*Microhyla* and *Tomopterna*) from Discoglossids through the Western Mediterranean land strips is quite probable.

It is unfortunate that none of the Indian species belonging to Pelobatidae have been examined so far for their opalinas. If such examinations were done, the data could well provide clinching evidence in support of their dispersal and adoption of commensals in southern India, which was once part of Lemuria. The most archaic families of Anura bear the most archaic opalina. Each new family group in the course of its evolution adopts through tadpoles opalinas of its ancestors. From the phylogeny of the opalina can thus be deduced the phylogeny of the frog host that carries the opalina with it. Further studies in this direction may provide significant data in the reconstruction of the phylogeny of an animal group that holds the status as the first land vertebrates.

ACKNOWLEDGEMENTS

I am grateful to Mr. J.C. Daniel of the BNHS, who, in response to my letter on the subject, suggested preparing this note.

November 17, 1987. J.C. UTTANGI

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## 29. OCCURRENCE OF *ANTHIAS TAENIATUS* (PISCES:SERRANIDAE) IN INDIAN WATERS

*(With two text-figures)*

With improvements in traditional boats and equipment, and with the introduction of modern methods of fishing (especially trawling), many hitherto unrecorded species and quite a few new species are being periodically recorded from Indian waters. Katayama (1978), in recording the species *Pseudanthias taeniatus* (Klunzinger) from Hachizo Island and the coast of Izu, Japan, gave a full description of the species.

In the course of taxonomic study on serranid fishes, I came across two specimens of *Anthias* from Vishakapatnam (17°44' N, 83° 23' E) which agree with *Anthias taeniatus* Klunzinger of Heemstra (1973), and with the description and the illustration of *P. taeniatus* of Katayama (1978).

Only two specimens were found in the trawl catches of Vishakapatnam in the month of April 1986. The two specimens differ in the length of the second pelvic fin ray. Descriptions, body measurements and meristic data are given in Table 1 to allow comparison with specimens described from other localities.

**Description:** A rather small, compressed *Anthias* fish, dorsal profile slightly more convex than ventral, maximum depth at dorsal origin. Mouth oblique, lower jaw anterior to upper, maxillary width equal to less than interorbital width, reaching to below posterior border of eye. Eye in middle of anterior half of head; interorbital slightly convex, less than eye diameter. One slightly enlarged caniniform tooth on each side of symphysis of either jaw; lower jaw with patches of small canines extending inwardly from each of these enlarged canines and running posteriorly in a narrow band on the dentaries. Another large, retrorse canine at the middle of each dentary. Upper jaw with an inner band of very small, depressible canine teeth and an outer row of larger, fixed canines. A pointed large canine exposed anteriorly on each side of upper jaw and visible externally when the mouth is closed. Medial to these two large outer canines is another pair of equally large, inner teeth which are directed posteriorly, pointing towards the vomers; there is a wide space between these two large inner canines, an arrowhead-shaped band of teeth on vomers; narrow band of teeth on palatines; patches of minute teeth on pharyngeals. Preopercle with a serrated vertical edge, two serrae along angle slightly larger. Opercle with three spines, middle one acute and closer to lower one. Head covered with ctenoid scales; maxilla covered with scales.

Dorsal origin slightly anterior to that of pectorals, whose origin is in front of that of pelvics; dorsal spines increasing in length posteriorly; eighth, ninth and tenth spines equal and longest. Fins naked, small scales at base of soft dorsal and anal. Pectorals long. In female specimen, pelvics reach the base of posterior end of anal base; in male specimen it reaches the third anal spine. Third anal spine longer and thinner than the second. Tip of soft dorsal and soft anal fins acute, caudal emerginate, lobes produced.

Colour dark pink; sexual dimorphism and sexual dichromatism observed in the present specimen as described by Katayama (1978).

Jones & Kumaran (1980) recorded *Anthias cichlops* from the Laccadive Islands. Smith (1961) synonymized *A. cichlops* with *A. taeniatus*. This is the first report from the continental shelf of mainland India.

I wish to express my thanks to the University Grants Commission, New Delhi, for financial help. I thank Prof. K.V.R. Murthy, Head of the Department of Marine Living Resources, Andhra University, for providing facilities.

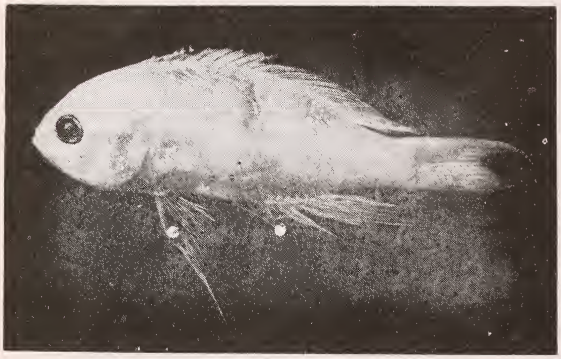

Fig. 1. *Anthias taeniatus* Male, 73 mm SL.

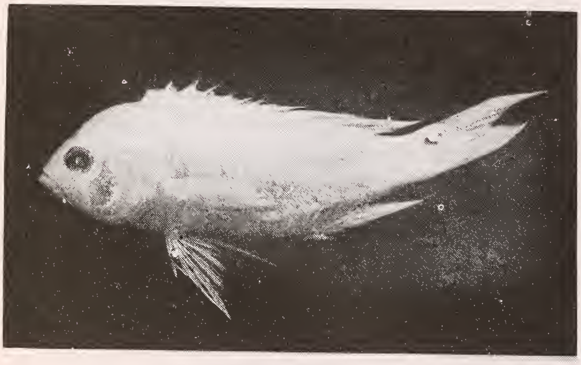

Fig. 2. *Anthias taeniatus* Female, 69 mm SL.

TABLE 1
MORPHOMETRIC AND MERISTIC CHARACTERS OF *Anthias taeniatus* FROM VISHAKAPATNAM

| | Male | Female |
|---|---|---|
| Standard length (mm) | 69 | 73 |
| As percentage of standard length: | | |
| Total length | 150.7 | 146.6 |
| Body depth | 31.9 | 34.3 |
| Head length | 34.8 | 34.3 |
| Predorsal distance | 31.9 | 30.1 |
| Prepectoral distance | 31.9 | 32.1 |
| Prepelvic distance | 36.2 | 34.3 |
| Preanal distance | 65.2 | 58.9 |
| Dorsal base | 65.2 | 61.6 |
| Anal base | 20.3 | 19.2 |
| First dorsal spine height | 5.8 | 6.8 |
| Posteriormost spine of dorsal height | 10.1 | 12.3 |
| Soft dorsal height | 20.3 | 24.7 |
| Pectoral length | 30.4 | 28.8 |
| Pelvic length | 36.2 | 49.3 |
| Anal height | 29.0 | 32.9 |
| As percentage of head length: | | |
| Head depth | 58.3 | 72.0 |
| Head width | 45.8 | 44.0 |
| Preorbital | 16.7 | 16.0 |
| Postorbital | 50.0 | 52.0 |
| Upper jaw | 41.7 | 40.0 |
| Lower jaw | 39.6 | 40.0 |
| Eye diameter | 25.0 | 24.0 |
| Interorbital | 20.8 | 24.0 |
| Snout length | 20.8 | 22.0 |
| Maxillary width | 20.8 | 20.0 |
| Meristic characters: | | |
| Dorsal | X, 17 | X, 17 |
| Anal | III, 7 | III, 7 |
| Pectoral | 19 | 19 |
| Gillrakers | 11+1+25 =37 | 11+1+25=37 |
| Lateral line scales | 48 | 46 |
| l.t r. | 4+1+20 | 5+1+20 |

September 14, 1988.

K. SUJATHA

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# 30.EATING OF MALES BY FEMALE *HIERODULA MEMBRANACEA* BURMEISTER (DICTYOPTERA: MANTIDAE)

Female praying mantids are known to bite off the head of the male while mating, or even progressively eat the mating male from head backwards, completely devouring it after mating. Some workers maintain that this behaviour is found only among undernourished females in the laboratory, but not in nature. Others tend to believe that the male is eaten because the female is unable to distinguish between the male (which is usually smaller than she is) and a prey species. Because cannibalism of such aggressive nature, unrelated to crowding, seems detrimental to species survival, reports of its occurrence are generally disbelieved. From the following observations it appears that the male-eating habit, rather than being detrimental, might be an aid to the survival of the species.

A field-collected nymph of *H. membranacea* was released into a laboratory cage and provided with a more than adequate supply of live butterflies, moths, grasshoppers, dragonflies and other insects. This feeding continued upto one week after it moulted into a female. A field-collected male, similarly fed in the laboratory in a separate cage, was then released into the cage of the female. The male settled down about 5 cm ahead of the female, facing the same direction. Both remained totally motionless for about 3 minutes, the female concentrating its attention on the male throughout. Then, suddenly, the female shot its raptorial forelegs forwards towards the male. The male, as if waiting for this move, half flew, half jumped onto the back of the female, and landed on it facing the opposite direction. It then slowly turned 180°, coming to rest after gaining a firm hold, especially on the leading edge of the female's wings, with its forelegs. The pair remained in this position for two days without making any positive attempt to mate, at least not while under observation, which lasted most of the day. Attempts to dislodge the male were unsuccessful. On the third day, when the cage was examined, only wings and bits and pieces of the limbs of the male remained, the rest having been devoured by the female. A week later the female laid eggs in a large ootheca, from which nymphs emerged a month later, confirming that mating had occurred before the male was eaten.

It could not be ascertained whether the head was bitten off before the male was eaten. If it had been, mating could have been hastened. The copulatory movement in the male is controlled by the last abdominal ganglion, over which the brain has inhibitory control. The removal of the brain by cutting off of the head can hasten copulation (Imms 1963). In fact, this method is employed by medical entomologists to induce mating in some anopheline mosquitoes in the laboratory; these otherwise do not readily mate under artificial conditions.

The deliberate nature of premating behaviour of both male and female *H. membranacea* in the cage shows that they could recognise each other as members of the same species. I have on another occasion noticed in the field an adult female *Gongylus gongylodes* (Linnaeus) (Empusidae) not attempting to grab a wasp even when the latter hovered close to it, well within striking distance. Slow-motion cinematographic studies of mantids attacking other mantids in defence of territory have shown that the striking mantid omits a dangerous part of the strike movement when confronted by a member of its own species. Mantids are also known to learn not to attack objects which are electrically connected to give a shock. (Mathews and Mathews 1978). Mantids, therefore, do have the ability to distinguish between their prey and members of their own species, and also between prey and other dangerous species of insects.

Even though the female *H. membranacea* was provided with an abundance of food, it resorted to cannibalism after mating. There could be a logical explanation for this. Since mantids have to lie in wait for their prey, there is an element of uncertainty as to when their next meal would come. Prolonged starvation by a mated female could prevent it from laying a full quota of well developed eggs. Eating the male therefore ensures an adequate supply of nourishment to the female for production of healthy offspring. In any case, leaving a beheaded male to die would be a waste. In the final analysis, therefore, the male- eating habit of the female mantid appears to support survival instead of being detrimental to it.

I thank Dr. R. Sambasiva Rao, Head of the Department of Microbiology, JIPMER, for facilities and Dr. J. Marshall of CAB International Institute of Entomology, London, for identifying the specimen.

September 24, 1987. E. NARAYANAN

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## 31. REDESCRIPTION OF THE WHITEFLY *ALEYRODES SHIZUOKENSIS* KUWANA (ALEYRODIDAE ; HOMOPTERA)

*(With three text-figures )*

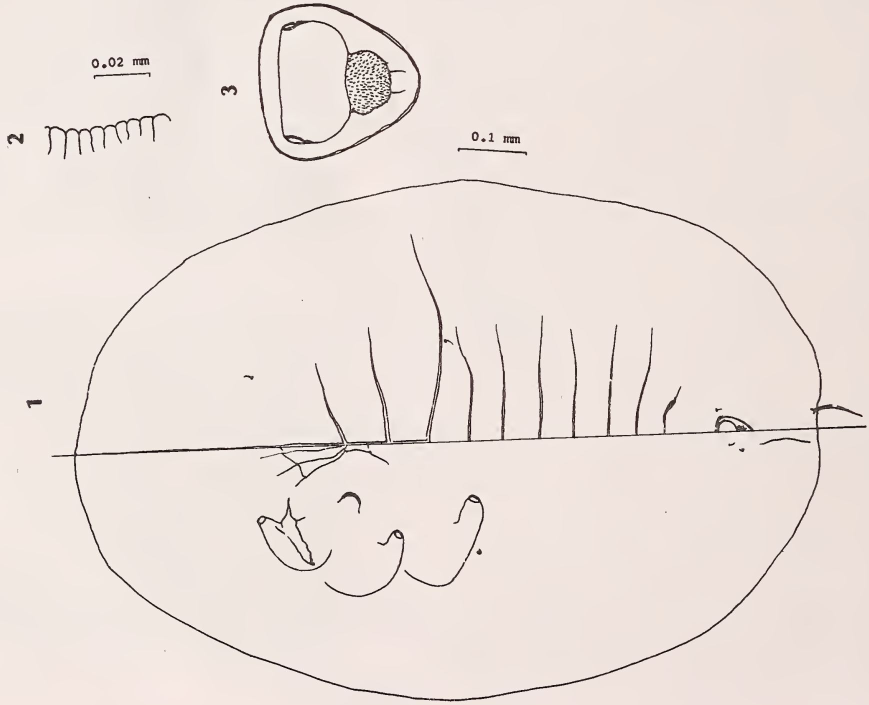
Two slides labelled *Aleyrodes shizuokensis* Kuwana, collected during April 1929 from *Oxalis corniculata*, were obtained from the Aleyrodid collections of the Division of Entomology, Indian Agricultural Research Institute, New Delhi, and studied in detail. As the earlier descriptions of the species by Kuwana (1911), Singh (1931) and Rao (1958) are inadequate, the species has been redescribed and illustrated, depicting the dorsal and ventral surfaces of the pupal case.

**Aleyrodes shizuokensis** Kuwana (Figs. 1-3)

*Pupal case:* Big, oval, 1.105 mm long and 0.798 mm wide; broadest across second abdominal segment area.

*Margin:* Finely crenate, 18 crenations in 0.1 mm, anterior and posterior marginal setae evident, measuring 15 and 32.5 microns long, respectively. Thoracic and caudal tracheal pore regions not differentiated from margin.

*Dorsal surface:* Submarginal ridges evident, subdorsal region with wax-secreting structures. Cephalic and first abdominal setae, 12.5 microns long and eighth abdominal setae 22.5 microns long. Caudal setae arising from submargin 52.5 microns long. Longitudinal and transverse moulting sutures thin, not reaching margin.



*Aleyrodes shizuokensis* Kuwana.
Fig. 1. Pupal case; 2. Margin; 3. Vasiform orifice.

Thoracic and abdominal segment sutures faintly represented. Seventh abdominal segment suture reduced to pockets. Abdominal segments 6, 7 and 8 almost of the same length, 42.5-45 microns long.

Vasiform orifice cordate shaped, 65 microns long and 60 microns wide; operculum subrectangular shaped, wider than long, 27.5 microns long and 45 microns wide, lingula tip exposed, 15 microns long, extruded out of operculum.

*Ventral surface:* Paired ventral abdominal setae 15 microns long and 55 microns apart, legs visible. Antenna not reaching beyond prothoracic legs, 80 microns long. Anterior and posterior abdominal spiracles, mouth parts and caudal tracheal fold discernible.

*Material examined:* Pupal cases mounted on two slides labelled "*Aleyrodes schizuokensis* Kuwana on *Oxalis* sp., 4.4.1929, K.S.L., R/7467; *Aleyrodes chizuokensis* Kuwana on *Oxalis* sp., 4.4.1929, K.S.L., R/7469".

*Hosts: Oxalis corniculata* (Kuwana 1911, Singh 1931); *Oxalis* sp. (Takahashi 1958); *Phyllanthus distinctus* (Rao 1958); *Sonchus oleracea* (Takahashi 1935).

*Distribution:* Pusa (Bihar) (Singh 1931); Hyderabad (Rao 1958); Japan (Kuwana 1911); Hawaii, Taiwan (Takahashi 1951).

ACKNOWLEDGEMENTS

We thank the Head, Division of Entomology, and Dr. (Miss) Swaraj Ghai, Systematic Entomologist, Indian Agricultural Research Institute, New Delhi, for the loan of the Aleyrodid specimens and thank the ICAR for financial assistance.

B.V. DAVID
October 7, 1987. R.W. A. JESUDASAN

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## 32. REDESCRIPTION OF TWO WHITEFLY SPECIES (ALEYRODIDAE:HOMOPTERA) FROM BURMA

*(With six text-figures)*

Two slides of aleyrodids labelled *Pealius kalawi* Singh and *Setaleyrodes takahashia* Singh, collected by Singh in 1933 respectively from *Laurus* sp. and *Streblus asper* at Kalaw (Burma) were obtained from the collections of the Zoological Survey of India, Calcutta, and studied. These two species are illustrated and redescribed in this paper as the earlier descriptions by Singh (1933) are inadequate.

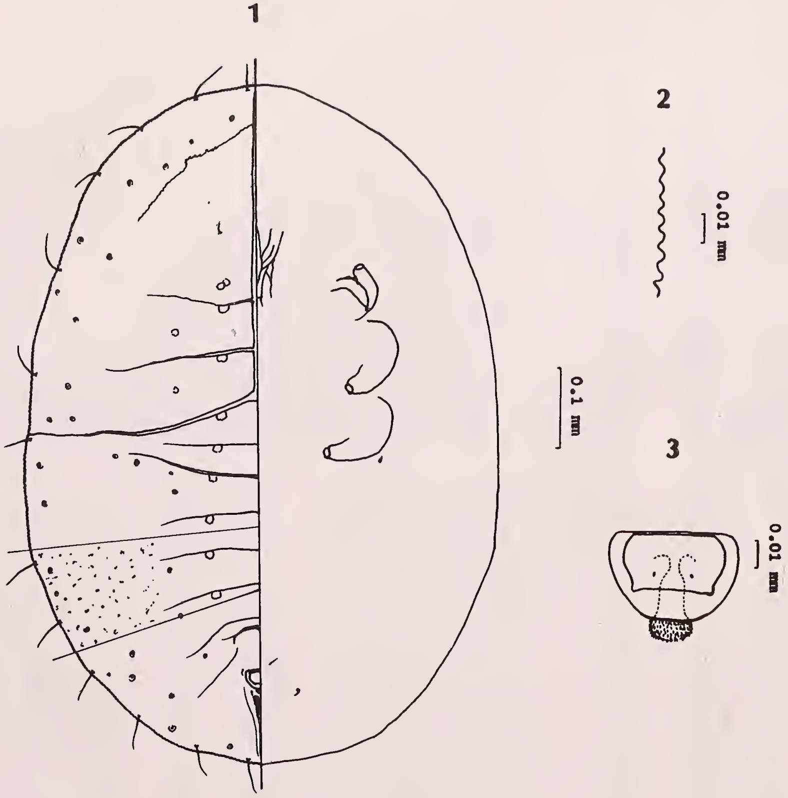
**Pealius kalawi** Singh, 1933 (Figs. 1–3)

*Pupal case:* Elliptical, 0.612–0.857 mm long and 0.428–0.627 mm wide.

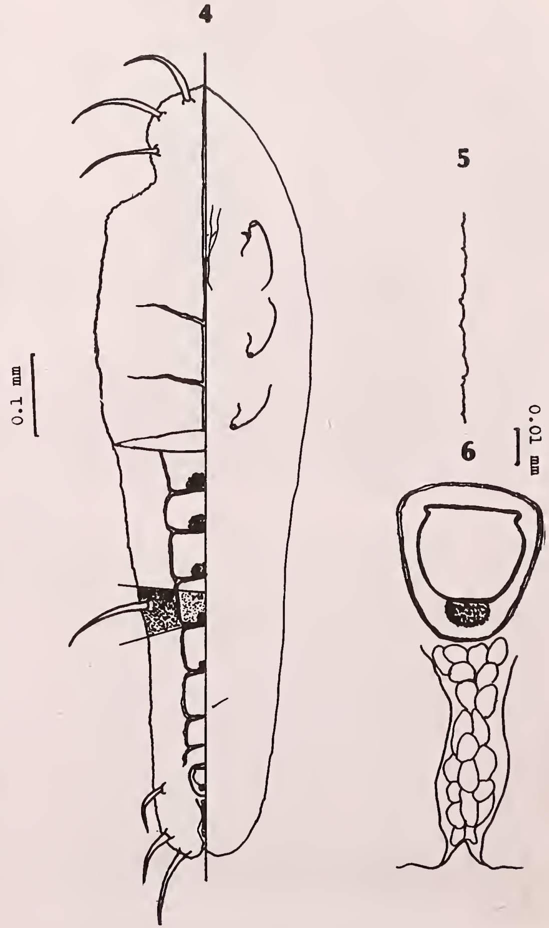
*Margin:* Regularly crenulate, 18–19 crenulations in 0.1 mm; thoracic and caudal tracheal pore regions not differentiated from margin.

*Dorsal surface:* Paired cephalic setae, minute, 7.9 microns long, paired eighth abdominal setae of the same length and paired caudal setae 80 microns long. 12 pairs of submarginal setae, 6 in the cephalothorax and 6 in the abdomen, 40–58.75 microns long. Submargin and subdorsum with sparsely distributed pores. Lateral depressions present in the median area of abdominal segments, a pair each on transverse moulting suture, first to sixth abdominal segment sutures and meso- and metathoracic sutures. Abdominal segment sutures distinct, except for first abdominal segment suture. Second abdominal segment suture more prominent than the other abdominal segment sutures. Seventh abdominal segment suture runs downwards and is reduced to pockets. Longitudinal and transverse moulting sutures reaching margin. Cephalothorax 380 microns and abdomen 460 microns long. Pores and granules evident on the submargin and subdorsal regions. First abdominal segment longest, 57.5 microns, succeeded by eighth abdominal segment 50 microns long, third and fourth abdominal segments 48.75 microns long. Abdominal segment three of the same length. Abdominal segments five, six and seven measuring respectively 45, 42.4 and 7.5 microns long.

Vasiform orifice rectangular shaped, wider than


1
2
0.01 mm
0.1 mm
3
0.01 mm

*Pealius kalawi* Singh
Fig. 1. Pupal case; 2. Margin; 3. Vasiform orifice.


4
0.1 mm
5
6
0.01 mm

*Setaleyrodes takahashia* Singh
Fig. 4. Pupal case; 5. Margin; 6. Vasiform orifice.

long, 27.5 microns long and 42.5 microns wide. Operculum similarly shaped, 17.5 microns long and 25 microns wide. Lingula 'D' shaped, extending beyond vasiform orifice, setose. Caudal furrow tassellated, broad at base of vasiform orifice which gets narrowed at posterior end, 88.75 microns long.

*Ventral surface:* Legs distinct, antennae nearly reaching base of prothoracic legs, paired ventral abdominal setae 17.5 microns long and 37.5 microns apart. Spiracles and mouth parts contiguous.

*Host: Laurus* sp. (Singh 1933)

*Material examined:* 2 pupal cases on slide labelled '*Pealius kalawi* Singh, on *Laurus* sp., Burma, K. Singh, 4598/H7'.

**Setaleyrodes takahashia** Singh, 1933 (Figs. 4-6)

*Pupal case:* White, elongate, measuring 0.800 mm long and 0.200 mm wide.

*Margin:* Irregularly crenate with 8-9 crenations in 0.1 mm; anterior and posterior marginal setae not discernible; thoracic pores, combs and teeth absent.

*Dorsal surface:* Submargin with seven pairs of setae arising on tubercles—3 in the cephalic region, 3 in the caudal region and a pair laterad of fourth abdominal segment 92.5 - 120 microns long. Submargin and subdorsum with intense granulations. Median tubercles evident on abdominal segments 1 - 5. Pro-meso and meso-meta thoracic sutures distinct. Abdominal segments with rhachis. Dorsal setae not discernible. Longitudinal and transverse moulting sutures reaching margin. Sixth, seventh and eighth abdominal segments respectively 55, 35 and 10 microns long.

Vasiform orifice subquadrate shaped, longer than wide, 50 microns long and 40 microns wide; operculum similarly shaped, as long as wide, 25 microns long; lingula setose and protruding beyond operculum. Caudal furrow 62.5 microns long with characteristic hexagonal granules.

*Ventral surface:* Thoracic and caudal tracheal folds absent; paired ventral abdominal setae on sixth abdominal segment region, 22.5 microns long and 32.5 microns apart. Antennae not discernible. Mouth parts and legs distinct.

*Host: Streblus asper* (Singh 1933)

*Material examined:* 1 pupal case on slide labelled '*Setaleyrodes takahashia* on *Streblus asper*, 12.7.1930, K. Singh, 4595/H7'

### ACKNOWLEDGEMENTS

Thanks are due to the Zoological Survey of India, Calcutta, for loan of the aleyrodid specimens and to the Indian Council for Agricultural Research for financial assistance.

B.V. DAVID
October 8, 1987. R.W. A. JESUDASAN

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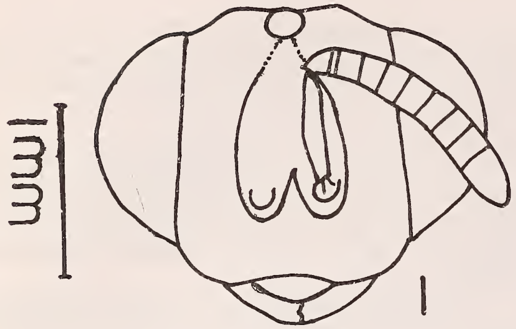
## 33. A STUDY OF SOME LITTLE KNOWN CHALCID WASPS (HYMENOPTERA : CHALCIDOIDEA)

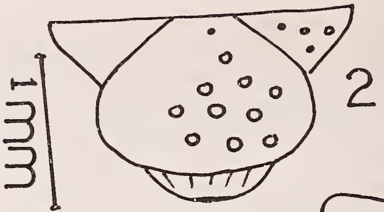
*(With six text-figures)*

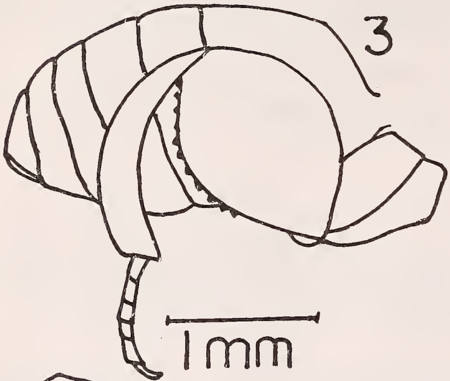
The species *Brachymeria madagascariensis* (Chalcididae) was originally described by Kieffer (1904) as the type-species of a new genus *Holochalcis* described by him. One of us (T.C.N.) examined the homotype of this species (obtained from the Museum National d'Histoire Naturelle, Paris) and found that the genus *Holochalcis* Kieffer is synonymous with the genus *Brachymeria* Westwood (Narendran 1987). Since the available description of *Brachymeria madagascariensis* (Kieffer) is quite inadequate for the recognition of the species, a redescription is provided here.

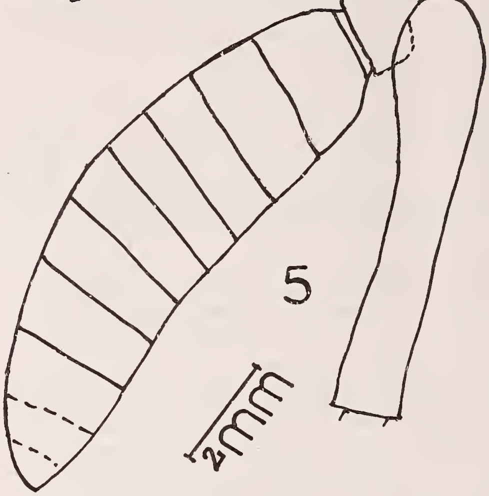
Until recently, Philomidinae was placed under Perilampidae. Boucek (1978) stated that 'Philomidinae seem to be placed best as a subfamily of Eucharitidae'. Narendran (1985, 1986) therefore placed the Philomidinae under Eucharitididae. Since Ayyar (1925) recorded an undetermined species of *Philomides* Haliday from India, no further report has been made of the genus from the Indian subcontinent. In this paper we record for the first time the species *Philomides paphius* Haliday from the Indian subcontinent (from Bangalore). Since the earlier descriptions of this species are not sufficient for easy identification, a redescription of the species is provided.

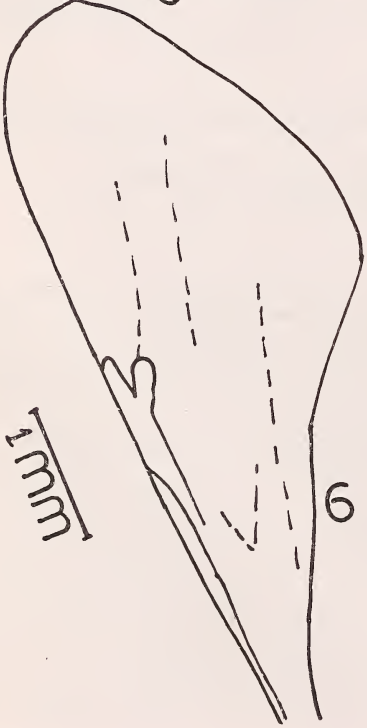
The four little known genera of the family Chalcididae, namely *Tainaniella* Masi, *Aspirhina* Kirby, *Xyphorachidia* Steffan and *Trichoxenia* Kirby share many common features and therefore look very similar, especially in having the apex of the scutellum prolonged posteriorly into a single stout structure. Students of Chalcididae who have not seen these genera may find difficulty in separating these genera with the help of already published information, which does not give any substan-

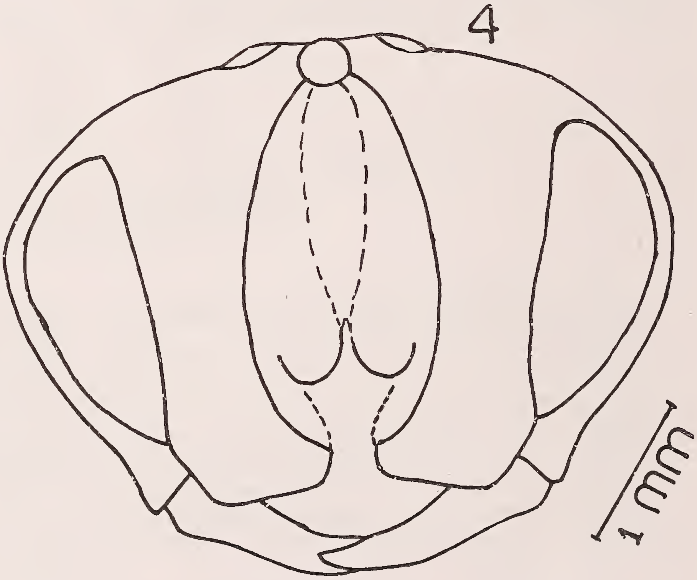












*Brachymeria madagascariensis* (Kieffer) Female.
Fig. 1. Head; 2. Scutellum; 3. Hind leg and gaster.
*Philomides paphius* Haliday Female.
Fig. 4. Head; 5. Antenna; 6. Forewing.

tial points for separating these similar-looking genera. Hence a comprehensive key for separating these four genera is provided here. This key is based on a study of primary types or homotypes by one of us (T.C.N.) during his period of study at the U.S. National Museum, Washington D.C., and at the British Museum (Natural History), London. The genus *Tainaniella* was described by Masi (1929) based on a species *Tainaniella subulifera* Masi collected by C.F. Baker from the Philippines. The genus *Aspirhina* was established by Kirby (1883) with the type species *Halticella dubitator* Walker from Santarem, South America (Walker 1862). Kirby (1883) also described *Trichoxenia* based on the type-species *Halticella cineraria* Walker from South Australia (Walker 1871). Steffan (1951) described *Xyphorachidia* based on *Xyphorachidia dentata* Steffan from West Africa.

**Brachymeria (Brachymeria) madagascariensis** (Kieffer) (Figs. 1-3)

*Female:* Length 5 mm. Black, with the following parts otherwise : Pedicel, scape, gaster, apices of hind coxae, hind femora (except apex) reddish brown. Hind tibia brownish yellow at apex and a faint yellow spot subbasally; hind tarsi immaculate yellow; fore and mid femora yellowish brown with extreme apex of femora yellow; fore and mid coxae yellowish brown; bases and apices of mid tibiae yellow with middle part yellowish brown. Tegulae pape yellow; eyes greyish; wings hyaline.

Head: Preorbital and postorbital carinae absent; scrobe hardly reaching front ocellus; scape never reaching front ocellus, distinctly away from front ocellus.

Thorax: Pits on scutellum, axillae, scapulae widely separated with interstices mostly smooth on scutellum, with microsculptures on axillae, scapulae, mesoscutum and pronotum. No coxal or inner basal femoral tooth present.

Gaster: With close microsculptures on first tergite on dorsal side. Ovipositor sheath not visible from dorsal side.

*Homotype* Female, MADAGASCAR: Inerina; Coll. P. Cassaboue and G. Grandi dier, 1902; Depository : Museum National d'Histoire Naturelle, Paris.

**Philomides paphius** Haliday (Figs. 4 - 6)

*Female:* Length 7.9 mm. Ochraceous yellow, with the following parts otherwise: a patch near and in between ocelli black; eyes black; small black patch on each side of mesoscutum, a small black patch on middle of mesoscutum; a black patch on base of scutellum; apex of scutellum black; black patches on ventral middle regions and dorsal middle regions of gaster; scrobe with median black colour. Pubescence golden yellow.

Head: Distinctly wider than thorax; relative measurements of OOL : POL = 72 : 56; frontogenal sulcus distinct but not carinate; frons convex on anterior dorsal part; antennal scape not reaching front ocellus; antenna short and very much thickened.

Thorax: Extremely wide and convex, pronotum not visible from above; mesonotum with parallel notaulices; scutellum projecting posteriorly; punctures close and interstices smooth on mesoscutum and carinate on scutellum. Forewing with a slight brown infuscation near apical region; relative measurements of veins : PM : M = 20 : 50; stigmal 18. Hind femora a little more than five times its maximum width, sparsely pitted, interstices smooth, pits rather deep.

Gaster: Distinctly shorter than thorax (110 : 75), first three tergites smooth, rest with microsculptures, ovipositor sheath and epipygium not visible from dorsal side.

*Pleasiotype* Female ; INDIA: Karnataka, Bangalore; 20 June 1976, coll. Unknown. Depository : Department of Zoology, University of Calicut.

### KEY FOR SEPARATING FOUR GENERA OF CHALCIDIDAE

1. Hind tibia with an extra external carina.................................2
Hind tibia without extra external carina.................................3
2. First gasteral tergite with several longitudinal carinae............
.........................................................................*Aspirhina* Kirby
First gasteral tergite without carinae; much larger species.........
.........................................................................*Trichoxenia* Kirby
3. Hind femur with three lobes on outer ventral margin, preorbital carinae projecting characteristically in profile, basal gasteral tergite with scattered microsculptures on dorsal side.....................................................*Xyphorachidia* Steffan
Hind femur bilobed or at the most unilobed; never trilobed; preorbital carinae not as above; basal tergite smooth and shiny..........................................................*Tainaniella* Masi

Remarks: There are a few other species under different genera of this family (Chalcididae) which also have projecting scutellum, but these are relatively much shorter than those of the four genera mentioned above. Apart from this, these few species such as *Paraspirhina nitida* Cameron, *Oxycoryphe edax* (Waterston), *Antrocephalus lugubris* Masi and *Belaspidia obscura* Masi do not resemble the four above- mentioned four genera at all.

### ACKNOWLEDGEMENTS

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TITUS T. JACOB

February 2, 1988.

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## 34. MATING BEHAVIOUR OF LAND LEECHESIN WESTERN GHATS (SOUTH INDIA)

*(With a text-figure)*

Information on the mating behaviour of land leeches is meagre except for the observations of Leslie (1951) and Harrison (1953). Intensive investigations on land leeches of the Western Ghats from 1967 to 1972, both in the field as well as in the laboratory, revealed some interesting aspects on the courting and mating behaviour of *Haemadipsa zeylanica zeylanica* Moore, *Haemadipsa zeylanica cochiniana* Moore and *Haemadipsa montana* Moore. A clear-cut variation from the basic pattern of mating behaviour as described by Harrison (1953) in *Haemadipsa zeylanica* was observed in *Haemadipsa montana* in 13 different localities of the Western Ghats, from Asambugiri hills in the southern region to Mercara in the northern region.

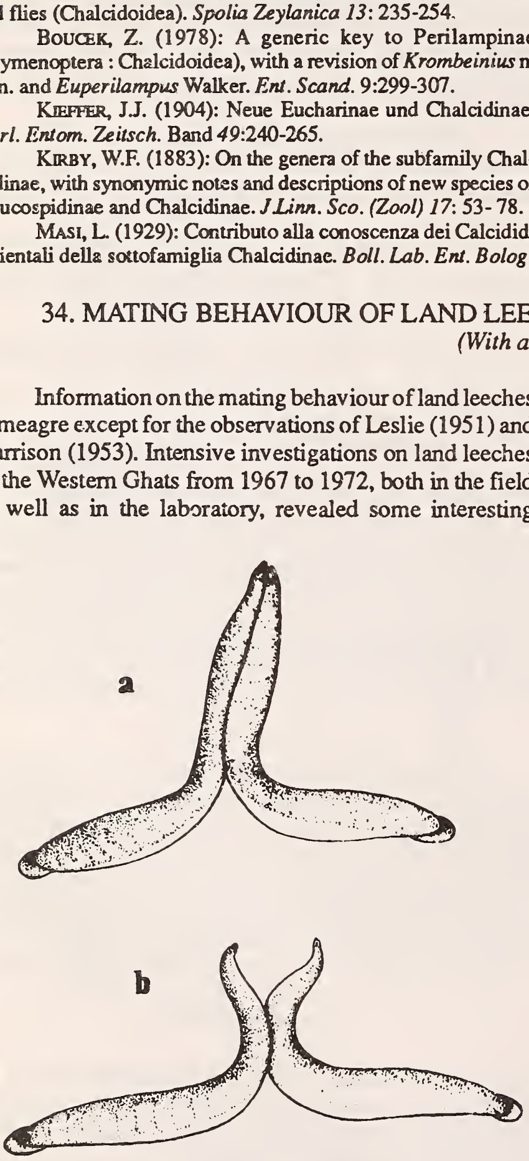

Fig. 1. a. Mating in *H. zeylanica*; b. Mating in *H. montana*

The basic pattern of embracing, called the 'Hollywood style' (Harrison 1953), was observed to be restricted only to *Haemadipsa zeylanica zeylanica* and *Haemadipsa zeylanica cochiniana* in the Western Ghats. On the other hand, in *Haemadipsa montana* the two mates exhibited a characteristic 'X' shaped posture instead of the basic pattern as described by Harrison (1953). Following characteristic tapping with their heads on the objects on which they move (Leslie 1951), the two mates come opposite each other and stand erect on their posterior suckers so as position their ventral surfaces in close contact at their clitellar regions. Further, the region anterior to the clitellum of each mate curls backwards and this results in a characteristic 'X' shaped posture (Fig. 1b). In this position, the male and the female gonopores of the two mates, situated on somites $Xb_5/b_6$ and $XIb_5/b_6$ are in direct contact with each other. Moreover, during this process, each mate pushes the other alternately back and forth to facilitate successful mating. Unlike in *Haemadipsa zeylanica*, where mating continues for several hours, mating in *Haemadipsa montana* is completed within about 20 minutes.

ACKNOWLEDGEMENTS

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November 26, 1988. M. GLADSTONE

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## 35. A FIRST RECORD OF THE ARANEID GENUS *POLTYS* C.L.KOCH (ARANEIDAE) FROM PUNE, MAHARASHTRA

*(With a text-figure)*

Only two species of the Araneid genus *Poltys* C.L. Koch 1843 have been reported from the Indian subcontinent, namely *Poltys bhabanii* (Tikader 1964) from Naya Bazar, Sikkim, and *P. nagpurensis* (Tikader & Bal 1982) from Nagpur, Maharashtra. Obviously, only the second species is available from Maharashtra and there are no records of this genus/species from any other part of India. While studying the nest-building activities and the habit of collecting spiders as larval food by *Scaliphron violaceum* (Dahib), it was observed that various species of spiders are collected by these wasps. It seems, from my study and the literature available on the subject, that the wasps are specialized, collecting only spiders belonging to particular families. The wasps in my study area collected spiders of the family Araneidae, but not those of other families. Additional collection details are given else-

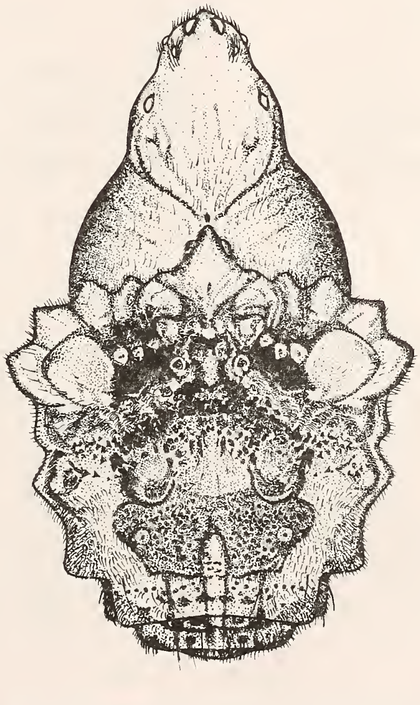

Fig. 1. Dorsal view of carapace and abdomen of *Poltys* sp. recorded from Poona (legs omitted).

where and are outside the scope of this note.

During one such observations I saw a female of the genus *Poltys* C.L. Koch being taken. This is very rare genus in India and is being reported for the first time from Pune.

The specimen collected by the wasp is an immature female. The morphological characters of this specimen do not tally with the known species either in description or in the illustration referred to in FAUNA OF INDIA, spiders (Araneae : Araneidae) 1982 pg. 166-179. Fig 1 shows the morphological characters for the specimen in. This note records the occurrence of the genus *Poltys* C.L. Koch in Pune, Maharashtra, and extends its distribution to western India.

January 3, 1989. D. BASTAWADE

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## 36. FLOWER-VISITORS AND POLLINATION OF *ADHATODA ZEYLANICA* (ACANTHACEAE)

(*With a text-figure*)

Plant-animal interactions, particularly at the flower level, are related to the structure, organisation and continued functioning of the respective communities (Heithaus 1974, Frankie 1976, Moldenke 1975, 1979). The need to understand such interactions, especially in the species-rich tropical ecosystems, is essential. This paper describes the interaction of 13 insect species with the flowers of *Adhatoda zeylanica* Medicus (Acanthaceae), a large tropical shrub and an important medicinal plant.

The plants flower at Vishakapatnam (17°42' N, 82°18' E) every year from mid January to early April. Flowers are borne in the axils of leafy bracts on a pedunculate spike inflorescence 5-9 cm long. They are zygomorphic, the corolla base forming a short tube

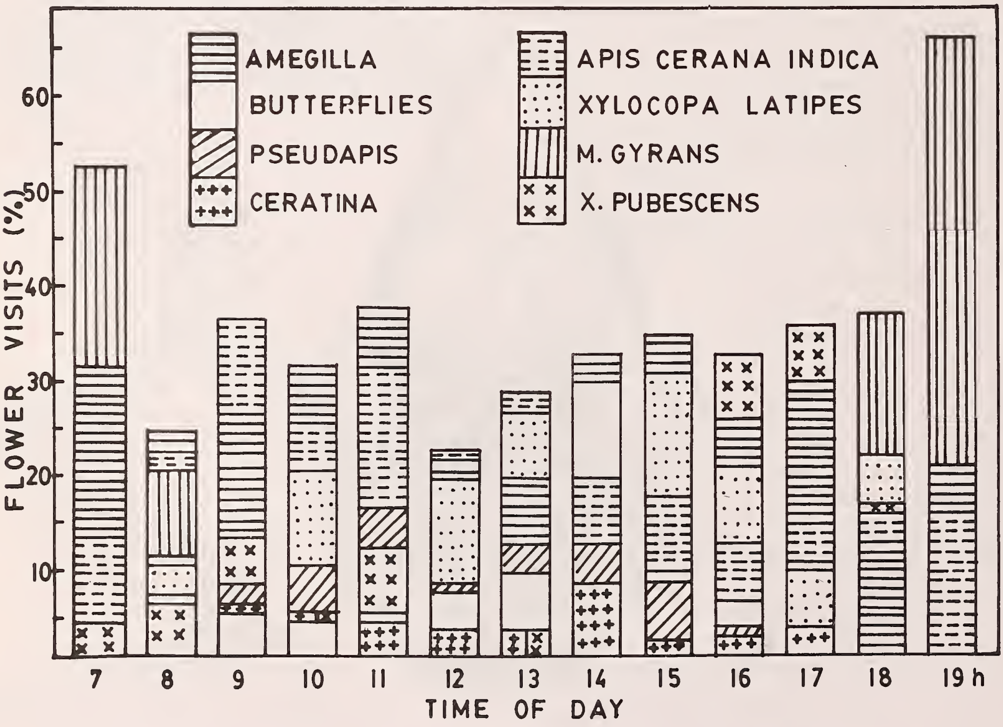

Fig. 1. Diurnal periodicity in foraging activity of different flower – visitors on *A. zeylanica*.

TABLE 1
FLOWER-VISITORS OF *A. zeylanica:* FORAGE TYPE AND VISITATION RATES IN

| Insect Species | Forage Type | | Flowering Phase | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Nectar | Pollen | Initial (%) 27 Jan 86 | | Peak (%) 17 Feb 86 | | Final (%) 22 March 86 | |
| HYMENOPTERA | | | | | | | | |
| **Bees** | | | | | | | | |
| *Apis cerana indica* | + | + | 445 | (33) | 654 | (20) | 443 | (28) |
| *Trigona* sp. | — | + | 65 | (5) | 78 | (2) | 74 | (5) |
| *Xylocopa pubescens* | + | | 0 | | 361 | (11) | 41 | (3) |
| *Xylocopa latipes* | + | — | 0 | | 409 | (13) | 102 | (6) |
| *Pseudapis oxybeloides* | — | + | 138 | (10) | 182 | (6) | 156 | (10) |
| *Ceratina* sp. | — | + | 92 | (7) | 106 | (3) | 115 | (7) |
| *Amegilla* sp. | + | + | 600 | (45) | 788 | (25) | 564 | (32) |
| *Pithitis binghami* | — | + | 0 | | 47 | (1.5) | 0 | |
| **Wasps** | | | | | | | | |
| *Delta conedus* | + | — | 0 | | 12 | (0.5) | 0 | |
| *Scolia* sp. | + | — | 0 | | 31 | (1) | 0 | |
| LEPIDOPTERA | | | | | | | | |
| **Moths** | | | | | | | | |
| *Macroglassum gyrans* | + | — | 0 | | 348 | (11) | 0 | |
| **Butterflies** | | | | | | | | |
| *Euploea core* | + | — | 0 | | 72 | (2) | 27 | (2) |
| *Pelopidas mathias* | + | — | 0 | | 122 | (4) | 45 | (3) |
| Total visits | | | 1340 | | 3210 | | 1567 | |

and the upper part becoming two-lipped and galeate. The outer three petals are imbricate; the opposite two are united, their facial margins forming a narrow groove through which passes the filiform style with its linear stigma. The two epipetalous stamens with the introrse anthers are inserted in the corolla over the most part of their length and are placed, together with the style, adjacent to and covered by the upper hooded corolla lobe. The style projects slightly beyond the stigma, thereby precluding contact with anthers when they dehisce.

Daily anthesis of flowers takes place in the period from 0730- 1830 hrs., a large number of flowers anthesing before 1100 hrs. Anthers dehisce shortly after anthesis, exposing the pollen, which is then visible to the naked eye as a white powdery mass. Pollen grains are large in size (65 x 45 microns), their number per anther averages 17800. Nectar secretion also begins with the anthesis, but in traces, and continues till the flower drops off after 48 hrs. of anthesis. Hand refractometer readings showed that the sugar concentration ranges from 17–22%. Paper chromatographic analysis revealed the sugars sucrose, glucose and fructose, the first dominating. Amino acids and proteins are present, as indicated by Ninhydrine and Bromo-phenol tests respectively.

In the flowering season of 1986, in all 13 insect species, 10 belonging to hymenoptra and 3 to lepidoptera, were found foraging at the flowers of *A. zeylanica* (Table 1). The visits of *Amegilla* sp., *Trigona* sp., *Ceratina* sp., *Pithitis* sp., and *Pseudapis* sp., among the hymenoptera were directed to pollen collection only. The other hymenoptera and the lepidoptera confined their visits to nectar foraging. The 13 species could only be recorded in the peak flowering phase, while in the other phases some of them did not appear. In all the three phases, *Amegilla* and *Apis c. indica* made a larger number of visits than other species. At the peak phase of flowering, besides these two species, *Xylocopa* and *Macroglossum* also shared a sizeable proportion of the total visits. The absence of *Xylocopa* in the initial phase could be understood because, in that period, it mostly concentrated on *Gliricidia sepium* (Jacq.) Kunth ex Walp. with a mass bloom.

All the 13 flower-visitors are diurnal in their activity. They visited the flowers during 0630-1900 hrs. The first to visit the flowers was *M. gyrans*. It foraged at the flowers for 2 hours in the morning and also for 2 hours in the evening, when other visitors were not that active. This type of stratified foraging behaviour probably is a strategy to avoid competition with other foragers. *Amegilla* and

*Apis* were active all through from 0630-1900 hrs. The activity of *Pseudapis* started late in the morning and ceased early in the evening, as also that of *Ceratina* and butterflies. Both the species of *Xylocopa* began their activity slightly later in the morning and finished it a little earlier in the evening (Fig. 1).

It is not possible to relate the activity of the various foragers to the weather parameters. It is assumed that the availability of forage might determine the visitation rates. Accordingly, in the period before 1100 hrs. there was a tendency to greater activity because a larger number of flowers open at that time. Although *M. gyrans* appeared to confine its activity to a cooler part of the day, observations of its activity on other plant species in the same biotope did not provide any support for such a behavioural pattern.

Data regarding the number of flowers visited per minute and the time spent on a flower by eight of the more common visitors indicated that *M. gyrans* was more mobile, covering on the average 57 flowers per minute and spending on the average 2 seconds per flower; the corresponding figures for others are *Trigona* 13.5 and 4.5; *Pseudapis* 12 and 4; *A.c. indica* 7.5 and 8.5; *Ceratina* 11 and 5.5; *Amegilla* 8 and 8.5.; *X. latipes* 6 and 12; *X. pubescens* 5 and 11.5.

Controlled experiments revealed the total absence of apomixis and spontaneous or direct autogamy. The 20 flowers tested for indirect autogamy yielded 50% fruit set with seeds set 100% and fecundity 50%. Those tested for geitonogamy yielded 75% fruit set, 100% seed set and 75% fecundity. Those for xenogamy gave 90% fruit set, 100% seed set and 90% fecundity. A close examination of the intrafloral behaviour of the 13 visitors revealed that only the carpenter bees (*Xylocopa* spp.) made meaningful contacts with the essential flower parts while foraging (Fig. 2), and vectored the pollen. The stamens and style, being placed adjacent to the upper lobe, brushed against the upper side of the visitor, thereby depositing or receiving pollen nototribically.

When the carpenter bee probes the flower for nectar, its body size fits exactly into the gap between the two corolla lobes. The zygomorphic nature of the flowers with the essential parts placed towards the upper lip is a precise adaptation for nototribic pollination by such large-bodied insects as *Xylocopa* (Proctor & Yeo 1972). The role of this bee in vectoring pollen was verified by examining the stigmas for pollen after the flowers were visited by different visitors. Only those stigmas visited by *Xylocopa* revealed pollen, thereby confirming the exclusive role of *Xylocopa* in pollination.

The pollinations that result from *Xylocopa* visitation of *A. zeylanica* flowers might be either auto-, geitono- or xeno-gamous. However, it was found that both the species of *Xylocopa* visited a few flowers in a foray and then flew away. This type of behaviour of the forager, together with the behaviour of the plant producing a small number of flowers per day and with minimal quantities of nectar, promote xenogamy which is a superior mode of reproduction in *A. zeylanica* (Faegri & Pijl 1979, Cruden 1976).

The visitors other than *Xylocopa* utilised the floral resource, but did not render pollination service. However, their interaction with the flowers assumes significance if it is treated from the ecosystem point of view. The visitors may be the essential pollinators of some other species in the same biotope which may bloom outside the season of *A. zeylanica*. It is important that they be maintained in the ecosystem until the right plants that require them for pollinatory service come into bloom (Baker *et al.* 1971).

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May 25, 1988.

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## 37. A NOTE ON *ACACIA CANESCENCE* COMPLEX

Heyne collected a plant from East India which was incorporated in Wallich's Catalogue under number 5253 A and was labelled *Acacia caesia* Willd. Bentham (1842), while studying the suborder Mimosoideae, considered it as a variety of *Acacia pennata* (Linn.) Willd. He called it variety 'heyneana'. He gave the Latin diagnosis for the variety, citing Wallich Catalogue no. 5253 A. He also cited *Acacia canescence* Grah. Wall. Cat. no. 5256. Thus, 5253 A and 5256 become the syntypes for the variety and it is proposed here to treat no. 5253 A as the lectotype for the variety.

Later, Bentham in 1875 did not mention this variety. He cited *A. caesia* Wall Cat. no. 5253 A and *Acacia canescence* Grah. Wall Cat. no. 5256 as synonyms of *Acacia pennata* (Linn.) Willd., thus merging his own variety with the type species. However, Baker (1879) treated *Acacia canenscence* Grah. Wall. Cat. 5256 as a variety of *A. pennata* (Linn.) Willd. and called it variety *canescence* Baker and cited no. 5253 A *A. caesia* Wall. as a synonym. Thus, it is clear that *Acacia pennata* (Linn.) Willd. var. *canescence* Baker (1879) is synonymous with *Acacia pennata* (Linn.) Willd. var. *heyneana* Benth. (1842).

Gamble (1919) considered *A. canescence* Grah. as a good species and provided the description of the species. Since then, *Acacia canescence* Grah. has been considered a validly published species. The correct citation for the species is as follows:

**Acacia canescence** Grah. ex Gamble Fl. Pres. Madras 1: 429, 1919 (Repr. ed. 1:304, 1957).

Britton (1936) described a species from Cundinamarca, Columbia, and called it *Poponax canescence* (Ann. N.Y. Acad. Sc. 35: 139, 1936). G. Barc & F. Gonzales (1969) transferred this species to the genus *Acacia* Mill. and called it *Acacia canescence* (Cat. Pl. Cundinamarca 3: 19, 1969). This plant has stipulary spines about 2 cm long. Hence it is different from *Acacia canescence* Grah. ex Gamble. Thus, *A. canescence* (Britton) Barc & Gonzl. is a later homonym of the Indian *A. canescence* Grah. ex Gamble (1919) in sense of Article 64 of the International Code of Botanical Nomenclature, and should be rejected.

It is proposed here to name the Columbian plant as *Acacia cundinamarcensis* Subhedar nom. nov. The specific epithet is adopted from the locality from where the plant was collected. Its correct name and its pertinent synonymy as follows:

*Acacia cundinamarcensis* Subhedar Nom. Nov. *Acacia canescence* (Britton) Barc. & Gonzl. in Cat. Pl. Cundinamarca 3:19, 1969; (non. Grah. ex Gamble); *Poponax canescence* Britton in Ann. N.Y. Acad. Sc. 35: 139, 1936.

The correct name and its pertinent synonymy of the Indian plant is as follows:

**Acacia pennata** (Linn.) Willd. var. **heyneana** Benth. in Hooker's London Jour. Bot. 4: 515-16, 1842. *A. caesia* Wall. Cat. 5253 A, 1831-32 (nom.nud.) (non Willd.). *Acacia canescence* Grah. in Wall. Cat. 5256, 1831-32 (Nom.nud.) Gamble, Fl. Pres. Madras 1: 429, 1919 (Repr. ed. 1: 304, 1957). *Acacia pennata* (Linn.) Willd. var. *canescence* Baker in Hooker's Fl. Brit. India 2: 298, 1879.

ACKNOWLEDGEMENTS

I thank Prof. P. V. Bole, Head of the Botany Department, St. Xavier's College, Bombay (Retired) for encouragement and for carefully going through the manuscript.

May 3, 1988. RAVINDRA P. SUBHEDAR

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BRITTON (1936): *Poponax canescence* Britton – New species from Cundinamarca. *Ann. N.Y. Acad. Sc.*. XXXV.

GAMBLE (1919): Flora of Presidency Madras Vol. I (Repr. ed. 1957).

## 38. *MEZONEURON HYMENOC ARPUM* PRAIN: A NEW DISTRIBUTIONAL RECORD FOR THE INDIAN MAINLAND

The genus *Mezoneuron* Desf. consists of 10 species distributed in tropical Asia and confined to the old world.

Out of the 4 species occurring in India, *Mezoneuron andamanicum* Prain and *M. hymenocarpum* Prain are distributed in Andamans, *M. enneaphyllum* (Roxb.) Wight & Arn. ex Benth and *M. cucullatum* (Roxb.) Wight & Arn. in the Western Ghats and the Andamans. *Mezoneuron hymenocarpum* Prain has been reported from the Andaman Islands, but not from the Indian mainland. This is the first report of the species from the Indian mainland, and the discovery of its new distribution in the central part of Kerala is phytogeographically interesting.

Some taxonomists (Hattink 1974) treat *Mezoneuron* Desf. under *Caesalpinia* L. in a broad sense. But, taking into consideration the prominent winged nature of the fruits in indigenous *Mezoneuron* spp., we feel that the 4 Indian species should be treated under the genus *Mezoneuron* Desf.

*Mezoneuron hymenocarpum* Prain, a prickly climbing shrub, was collected from Panjanamkattu area of Vazhachal Forest Division, Kerala. The flora of this division is interesting; we found some rare and interesting plants there, namely *Glycosmis macrocarpa* Wight, *Rhynchosia acutissima* Thw. and *Derris canarensis* (Dalz.) Baker. The occurrence of many such plants show that there is need for further exploration of the flora of this division. As this ecosystem shelters many rare and valuable gene pools, it should be conserved and protected.

*Mezoneuron hymnocarpum* Prain differs from the common Indian species *M. cucullatum* (Roxb.) Wight & Arn. in having pubescent branchlets, small-sized leaflets, shedding fruiting receptacles, broader wing of pods and a larger number of seeds. A key for differentiating the 4 Indian species of *Mezoneuron* Desf. and a sketch of the fruiting specimen of *M. hymenocarpum* Prain are provided for easy identification in the field.

KEY TO THE SPECIES OF *Mezoneuron* DESF. IN INDIA

1. Leaflets 5–12 pairs per pinna, small, less than 2 cm long; stalk of the leaflets 0.5 – 1 mm.
    2. Pedicel of fruit 8-15 mm long; tip of fruit usually hooked ........................................................ *M. hymenocarpum*
    2. Pedicel of fruit 15–20 mm long; tip of fruit acute ........................................................ *M. enneaphyllum*
1. Leaflets 3–6 pairs per pinna, large, over 2 cm. long; stalk of the leaflets 2–4 mm.
    3. Leaflets acuminate at apex, coriaceous; seeds 1, rarely 2 per fruit ................................................ *M. cucullatum*
    3. Leaflets rounded or retuse at apex, membranous; seeds 3–4 per fruit ......................................... *M. andamanicum*

The habitat of *mezoneuron hymenocarpum* Prain is the evergreen forest. The important associates include *Canavalia ensiformis* DC., *Diospyros microphylla* Bedd., *Bauhinia vahlii* Wt. & Arn., *Persea macrantha* (Nees) Kosterm., *Ochlandra travancorica* Gamble, *Vitex altissima* L.f., *Xanthophyllum flavescens* Roxb., *Aporosa lindleyana* Baill., *Glochidion ellipticum* Wt., *Olea dioica* Roxb., *Calamus pseudotenuis* Becc. and *Hopea parviflora* Bedd.

*Fruiting* - December.

*Distribution* - Sri Lanka, China, Burma, India, Indo-China, Thailand, Malaysia, Java, Lesser Sunda Islands.

*Specimens examined* - *FRC* 10851, Panjanamkattu (Vazhachal Forest Division, Kerala); *MH* 65813, Burma.

K.N. SUBRAMANIAN
B. GURUDEV SINGH
K.R. SASIDHARAN

May 27, 1988.

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## 39. *SYNEDRELLA VIALIS* (LESS.) A. GRAY: A NEW RECORD FOR UTTAR PRADESH, INDIA

During botanical exploration in the Doon Valley we collected a weed from New Forest, Dehra Dun. On checking with literature it was identified as *Synedrella vialis* (Asteraceae), a native of South America. From India this species is so far reported from Poona, Maharashtra (Ahuja & Pataskar 1969, Rao *et al.* 1988). It is now being reported for the first time from North India.

Synedrella vialis (Less.) A. Gray in Proc. Am. Acad. 17:217. 1882; Ahuja & Pataskar in Ind. For. 95:267. Figs. 1-8. 1969; Rao *et al.*, Fl. Ind. Enum. Astera. 74. 1988. *Calyptocarpus vialis* Less. Syn. 221. 1832. et in Linnaea 269. 1834; DC. Prodr. 5:630. 1839.

Herbs. Annual, branching from the base, spreading and rooting at nodes, more or less scabrid-hairy. *Leaves* opposite, simple, petiolate, ovate-lanceolate, cuneate at the base, acute at the apex, shortly hairy on both surfaces, 3-4 x 2-3.2 cm, serrate, 3- nerved from the base; petiole ciliate. *Heads* axillary, usually solitary or sometimes two, sessile; when two, one pedunculate; peduncle up to 3 cm long; outer involucral bracts 4, herbaceous, ovoid or oblong-lanceolate, shortly hairy, ciliate along margin, each up to 7 x 4 mm; inner bracts linear- lanceolate, paleaceous, 5 x 1 mm, merging into paleae of the receptacle. *Outer florets* ligulate, 5-9, female, yellow, 2-3-lobed at the apex. *Inner florets* tubular, limb 4-fid, hermaphrodite; stamens 4, epipetalous, syngenesious, anthers appendaged at the apex and tailed at the base. Style of both the female and hermaphrodite florets bifid. *Achenes* dimorphic; those of ray-florets dorsally compressed, narrowly winged, crowned with 2 spines, those of disc florets dorsally compressed and crowned with 2 spines or triquetrous and crowned with 3 spines, scabrid, spines half as long as the achenes, shortly hairy.

*Specimens Examined:*

New Forest, Dehra Dun, 28 August 1988, *Sumer Chandra* 150 (DD) and 30 August 1988, *H.B. Naithani* 1529 (DD).

H.B. NAITHANI
December 1, 1988. SUMER CHANDRA

## 40. SOME NEW COMBINATIONS IN THE SUBTRIBE LACTUCEAE (ASTERACEAE)

The members of the complex subtribe Lactuceae are morphologically inter-related and show overlapping characters. During the course of a critical study on the taxonomic revision of the subtribe Lactuceae, a few important characters to distinguish all the genera were recognised. Members like *Mulgedium*, *Cicerbita* and *Lactuca* are very closely allied but can be differentiated as follows:

In *Cicerbita* involucral bracts are in more than 3-series, gradually passing into inner, and usually blackish bristly hairy, whereas in *Mulgedium* and *Lactuca* involucral bracts are usually 2-3 seriate, differentiated into outer and inner bracts and usually glabrous or sparsely hairy. Further, in *Cicerbita* involucres are usually broad, and campanulate and achenes are ovate or elliptic, subcompressed with a small beak, whereas in *Mulgedium* and *Lactuca* involucres are comparatively small or medium sized, usually cylindric and achenes are oblanceolate or lanceolate, finely compressed with a small or a long beak.

Subsequently *Lactuca gracilis* has been transferred to the genus *Ixeris*, therefore variety *khasiana* automatically deserves a new combination. Similarly, *Picridium tingitana* has been transferred to the genus *Reichardia, therefore variety subintegra* also deserves a new combination.

Keeping in view the above justifications we suggest the following new combinations.

**Cicerbita filicina** (Duthie ex Stebbins) Mamgain & Rao, comb. nov.
Basionym: *Lactuca filicina* Duthie ex Stebbins in Ind. For. Rec. Bot. 1(6): 241:1939.
**Cicerbita cyanea** (D. Don) Beauverd var. **paniculata** (Clarke) Mamgain & Rao, comb. nov. Basionym: *Lactuca hastata* Wall. ex DC. var. *paniculata* Clarke, Comp. Ind. 268. 1876.
**Cicerbita cyanea** (D. Don) Beauverd var. **khasiana** (Clarke) Mamgain & Rao, comb. nov.
Basionym: *Lactuca hastata* Wall. ex DC. var. *khasiana* Clarke, Comp. Ind. 268. 1876.
**Cicerbita lessertiana** (Wall. ex DC.) Mamgain & Rao, comb. nov.
Basionym: *Mulgedium lessertianum* Wall. ex DC. Prodr. 7: 251. 1838.
**Cicerbita lessertiana** subsp. **dentata** (DC.) Mamgain & Rao, comb. nov. et stat. nov.
Basionym: *Mulgedium lessertianum* var. *dentatum* DC. Prodr. 7.
**Cicerbita lessertiana** subsp. **lyrata** (Decne.) mamgain & Rao, comb. nov. et stat. nov.
Basionym: *Melanoseris lyrata* Decne. in Jacqu, Voy. 4. Bot. 101. t. 109. 1844.
**Ixeris gracilis** (Wall. ex DC.) Stebbins var. **khasiana** (Hook.f.) Mamgain & Rao, comb. nov.
Basionym: *Lactuca gracilis* Wall. ex DC. var. *khasiana* Hook.f. Fl. Brit. Ind. 411. 1881.
**Reichardia tingitana** (Linn.) Roth, var. *subintegra* (Boisser) Mamgain & Rao, comb. nov. Basionym: *Picridium tingitanum* (Linn.) Desf. var. *subintegra* Boisser, Fl. Ori. 3:828. 1875.

### ACKNOWLEDGEMENTS

We are grateful to the Director, Botanical Survey of India, Calcutta, for facilities.

S.K. MAMGAIN
September 9, 1988 R.R. RAO

## 41. PLANTS IN RELATION TO SOCIO-CULTURE OF LADAKH

Folklore, mythological stories and the epics, as also innumerable religious practices in households and temples, in festivals, births and deaths are all replete with references to plants. Perhaps as a consequence of his dependence on plants, man has incorporated them into his religion, language, art, drama and recreation.

The social and cultural traditions of the Ladakh region, Jammu and Kashmir, are markedly different from those of any other part of India. Until recently the traditional way of life had seen little change over centuries. However, Ladakh has become more and more exposed to outside influences, which threaten its unique culture.

During the last few years we have been studying the ethnobotany of Ladakh. Certain plants are intricately linked with culture and traditions of the people. Enumerated below are a few such plants. For each plant is given name, citation, locality, collection number and role; family name is given in parenthesis.

**Arnebia guttata** Bunge. Ind. Sem. Horti. Dorpat, 1840:7,1840. *'Deemok'* Karoo (3400 m) IN 69. (BORAGINACEAE)

Fresh roots on crushing yield a red dye. The dye is used to decorate the idols of Buddha made from ash and clay. *Mandala* or *prashad* made from *sathu* (fried wheat flour) is also ornamented with red dye. The dye is also used to paint interiors of private chapels by poorer Ladakhis who cannot afford paints.

**Descuriana sophia** (Linn.) Webb. Berth. Pflanzaf. 3(2): 192, 1891. *'Deschamchsce'* Phiyang (3500 m) IN 176. (BRASSOCACEAE).

A sacred plant of Ladakhi Buddhists. It is usually planted along the borders of cultivated fields and around houses. It is claimed to increase crop production and to bring happiness to the household. Plants are kept near the heap of harvested crops. Seeds are usually carried along during journeys as protection against evil spirits.

**Inula obtusifolia** Kerner in Ber. Naturw. Verz. Insbruk I:

111,1870. *'Minchennakpo'* Khardungla (5600 m) IN 366. (ASTERACEAE)

Fresh flowers are usually spread on the corpse of the deceased during recital from the holy books. After the rites are completed these flowers are taken to the temple and kept at the feet of the Buddha's idol for 12 hours. Next morning the flowers are thrown into the river. Flowers are also spread on the corpse before laying it on the funeral pyre.

**Juglans regia** Linn. Sp. Pl. 997, 1753. *'Starga'* Panamick (3250 m) IN 3616. (JUGLANDACEAE)

The wood is used for printing blocks for Buddhist prayers. The prayers are engraved on the rectangular blocks known as *'Genzenchema'*. Later, using black or red dye, these prayers are printed on muslin cloth flags of 12" x 12" or 12" x 9" dimensions.

**Juniperus communis** Linn. var. **saxatilis** Pall. Fl. Ross.

1, 2: 12t. 4, 1788. *'Shukpa'* Gumri (3400 m) IN 1707. (CUPRESSACEAE)

Dried twigs are used as incense at all religious and cultural ceremonies. During crop sowing or harvesting *shukpa* fires are lit along the borders of crop fields under vertically erected stones. When religious processions are taken out, these fires are lit along the route of the procession and are also carried along in specially prepared metallic pots.

**Potentilla argyrophylla** Wall. ex Lehm. Pugill 3: 36, 1831.

*'Balchar'* Khardungla (5600 m). (ROSACEAE)

Dried plant is burnt as incense with *shukpa* (*Juniperus communis*).

**Waldhemia tomentosa** (Dcne.) Regel. I.C. 308, 1879.

*'Pallu'* Khardungla (5600 m) IN 349. (ASTERACEAE)

Dried plants are burnt as incense during all religious and cultural ceremonies.

G.M. BUTH
November 1, 1988. IRSHAD A. NAVCHOO

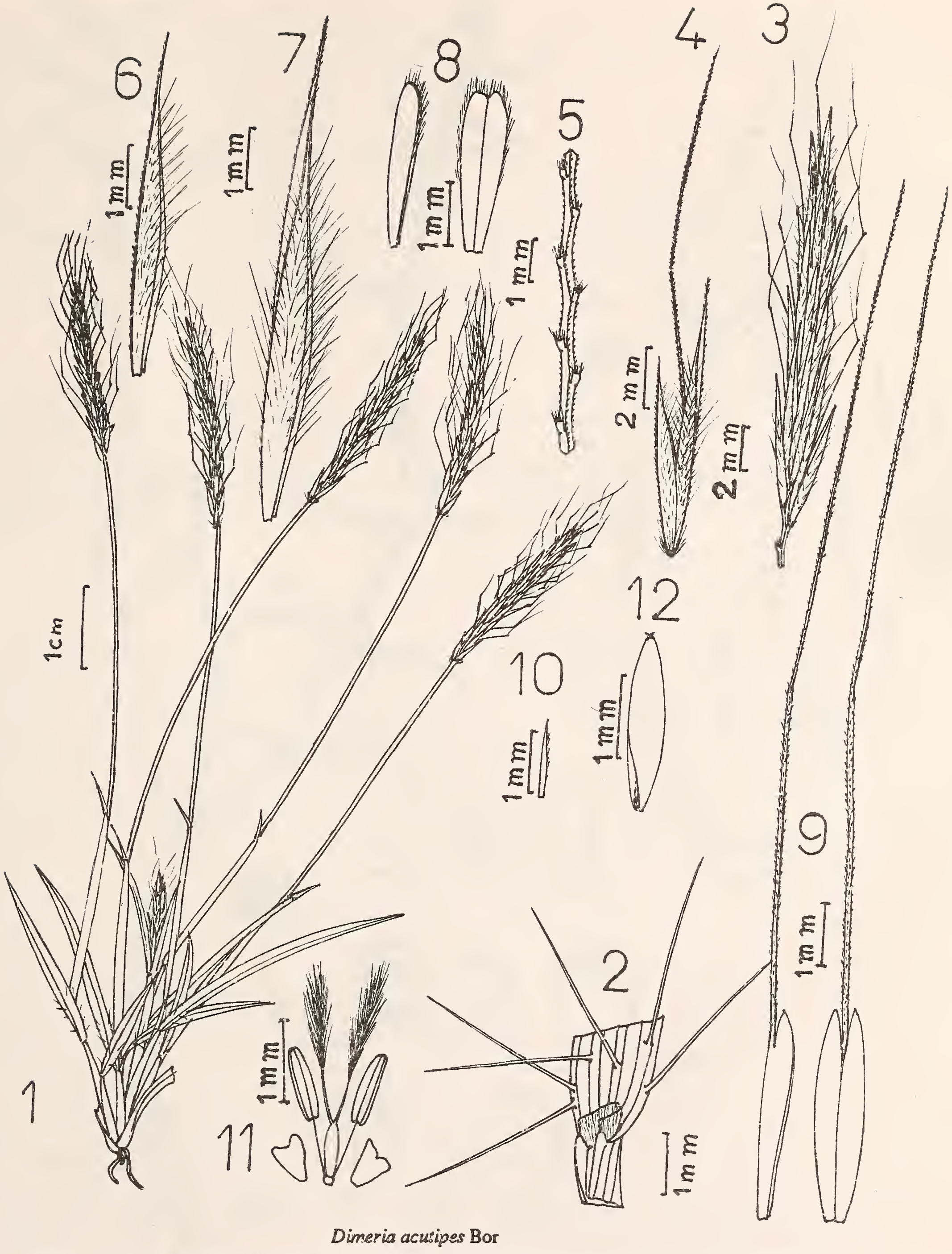
## 42. ON THE OCCURRENCE OF *DIMERIA ACUTIPES* BOR (GRAMINEAE) IN TAMIL NADU

*(With a text-figure)*

Bor (1952) had described *Dimeria acutipes* as endemic to Tamil Nadu, based on Bourne's collection (35, Type K) made in 1898 on the outskirts of Madras City. Since then, this species has remained uncollected and consequently little-known. There are no specimens at MH, Coimbatore. Karthikeyan (1971) and Nayar & Ramamurthy (1973) have mentioned this species as an addition to Flora of Madras and Flora of India respectively and quoted distributional data from the protologue. Nair and Nair (1981) listed this species as a rare one, known only from type collection. They suggested that the species could possibly be extinct.

I have twice collected *Dimeria acutipes* between 1984 and 1986, from Narthamalai in Pudukottai District. The collections were made from fallow fields after the monsoon. They generally grow in association with *Apocopis mangalorensis*. These collections are thus a rediscovery of the species after nearly 90 years. They have been identified by T.A. Cope at Kew. A brief description and illustrations are provide here to facilitate collection and identification.

**Dimeria acutipes**: Bor in Kew Bull. 7: 560. 1952 & Grass. India 138. 1960.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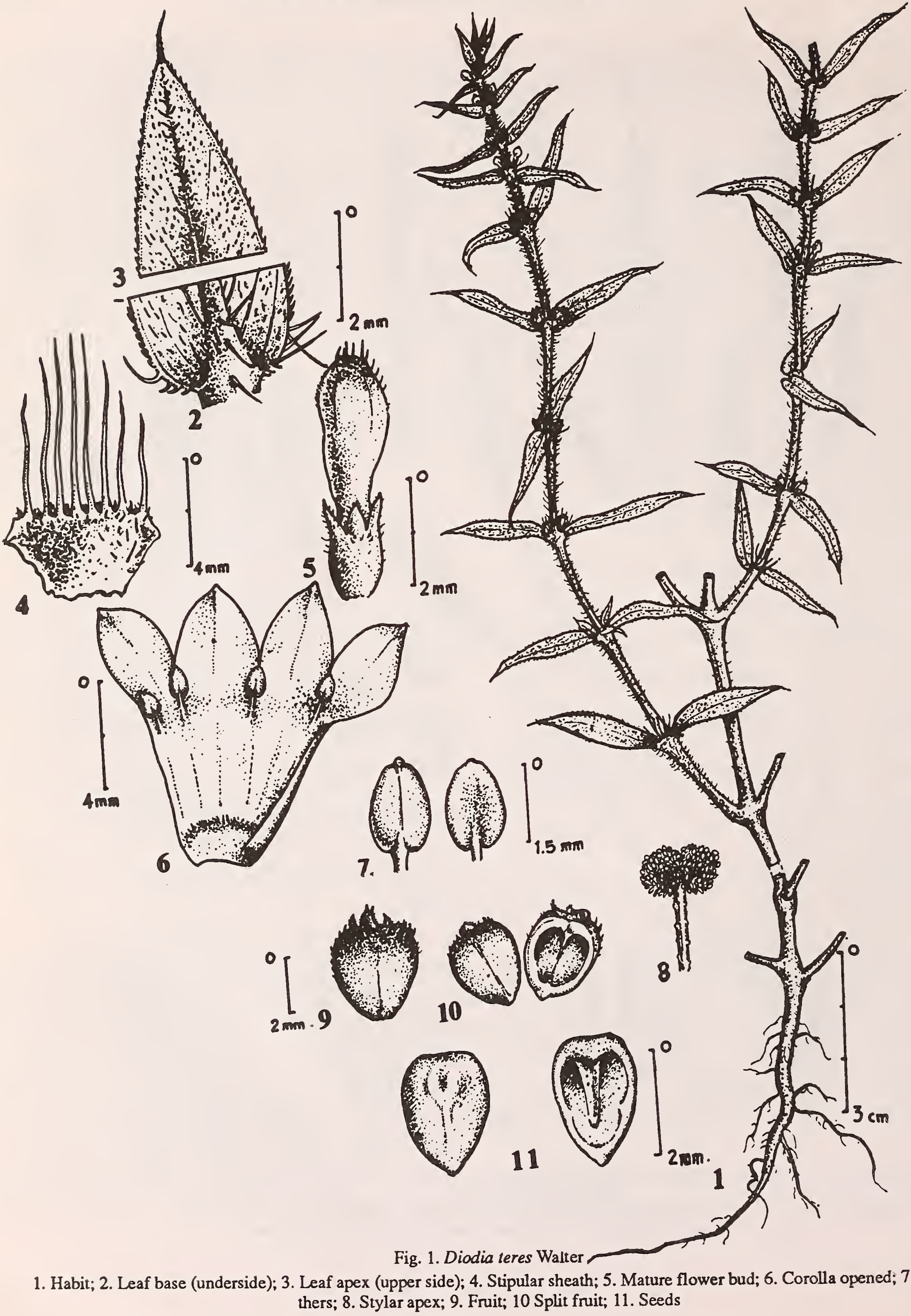
*Dimeria acutipes* Bor

1. Habit; 2. Ligule; 3. Raceme; 4. Spikelet; 5. Rachis; 6. Lower glume; 7. Upper glume; 8. Lower lemma; 9. Upper lemma; 10. Upper palea; 11. Lodicules, stamens and pistil; 12. Caryopsis.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1

Fig. 1. *Diodia teres* Walter

1. Habit; 2. Leaf base (underside); 3. Leaf apex (upper side); 4. Stipular sheath; 5. Mature flower bud; 6. Corolla opened; 7. Anthers; 8. Stylar apex; 9. Fruit; 10 Split fruit; 11. Seeds

Annual. Culms 10–15 cm, slender, erect, glabrous, densely hairy at nodes. Leaf-sheaths 1–2.5 cm long; ligule membranous, apically ciliate; leaf-blades linear-lanceolate, 1–4.5 x 0.1–0.2 cm, sparsely tuberculate-pilose on the upper surface. Raceme solitary, spiciform, to 3 cm, somewhat flexuous; pedicels obliquely articulate with callus. Spikelets up to 6 mm (arista & awn excluded). Glumes compressed, stiff-pilose from below the middle to the apex, scabrid along keels. Lower floret empty; upper one bisexual; awn of upper glume to 3.5 mm; upper lemma 3.5– 5.5 mm, cleft above, awn at sinus 0.8–1.5 cm long. Stamens 2. Caryopsis linear, to 2.5 mm, laterally compressed. Common in fallow fields and sandy tracts, during rainy season.

*Specimens examined:* Pudukottai Dist., Narthamalai: S.J. Britto. RHT 29660, 30576, 30577, 30578 (RHT, K).

ACKNOWLEDGEMENTS

I am grateful to Dr. T. A. Cope of Royal Botanic Garden, Kew, for the determination of this species. Thanks are also due to S. Karthikeyan, BSI, Pune for useful suggestions.

August 27, 1988. S.J. BRITTO

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## 43. *DIODIA* LINN. (RUBIACEAE): A NEW GENERIC REPORT FROM INDIA

*(With a text-figure)*

We collected specimens of a Rubiaceae species from the Sree Narayana College Campus and adjacent areas in Chathannoor, near the coastal town of Quilon in Quilon District, Kerala, South India. Detailed study of the vegetative and floral characters of the plant revealed its distinctness from all the known Indian Rubiaceous genera. Subsequently the plant was identified as *Diodia teres* Walter by the Royal Botanic Gardens, Kew. As none of the Indian Floras, past or present, deal with any species of *Diodia* L., the present paper is a new record for the genus in India. According to Kew, *D. teres* is a New World species, so far reported outside the New World only from Angola, Senegal and Japan. This collection is thus a new record to the Indian Flora.

*Diodia* L. is closely allied to *Spermacoce* L. (in the broad sense) and *Richardia* L. in the general vegetative and floral characters, but is distinct from both in the mode of dehiscence of the fruit. While the fruit is a schizocarp in both *Diodia* and *Richardia*– splitting into 2 cocci in the former and into more than 2 cocci in the latter—the fruit is a variously dehiscent septicidal capsule in *Spermacoce*.

As the taxon is new to Indian Flora, a description and drawings made on the basis of study of fresh specimens are presented here for the benefit of Indian botanists.

**Diodia teres** Walter sensu lato (Steyermark in Mem. New York Bot. Garden. 23: 799 (1972)).

Annual erect to diffuse herb. *Stem* 4-angled, to 30 cm long, hirsute-hairy. *Leaves* sessile, linear-elliptic to lanceolate, upto 3.5 cm long and 1 cm broad with recurved scabrous margins, acute to acuminate apex ending in a stiff arista, broadly cuneate to round base, midrib prominently impressed above and raised below, veins 4–5, obscure above, slightly raised below, puberulous above and below, prominently so on the raised veins below with strigose hairs added on both sides and broad leaf base; Stipular sheath more or less truncate at apex, strigose outside with 8 to 9 linear slender teeth upto 1 cm long, shortly hairy at the base, glabrous otherwise, insterspersed with more or less club-shaped glandular hairs. *Flowers* 1 to 4 per axil, sessile. *Sepals* 4, short, subequal, triangular-acute, scabrous on the margins, persistent. *Corolla* mauve, funnel-form, tube 4 to 5 mm long with a ring of short hairs at the base, glabrous otherwise on the inside, lobes 4, triangular-ovate, acute–apiculate at apex, 2 to 3 mm long, as broad as long or slightly less, puberulous on the outside with a few bristly hairs towards the tip. *Stamens* 4, inserted at the mouth of the tube, anthers short, 2-celled, filament as long as or shorter than the anther. *Ovary* 2 mm long, half as broad as long, shortly hairy towards the apex and glabrous towards the base, 2 celled, each cell with a single basal axile ovule; disc small and annular; style slender, about 4.5 mm long, bluntly tuberculate towards the apex; stigma capitate, 2–lobed, papillate. *Fruit* obovate to spherical with the persistent calyx teeth, 3.5 to 4 mm long, shortly hairy towards the apex, glabrous towards the base, splitting into 2 indehiscent cocci and falling at maturity from the leaf axil, Seeds flattened-obovate, smooth, pale brown, concave on the ventral face with a longitudinal ridge, apically incurved.

The herbarium specimen Ravi 2429 A, Chathannoor, 6-7-1988, has been deposited in the Kew Herbarium, England, and its duplicates 2429 B, 2429 C and 2429 D have been deposited in the CNH, Howrah, MH, Coimbatore and Sree Narayana College Herbarium, Quilon, respectively.

We thank the Director, Royal Botanic Gardens, Kew, for identifying the taxon.

N. RAVI
N. ANILKUMAR
December 13, 1988. T.K. BALACHANDRAN

## 44. A NOTE ON THE ANOMALOUS FLOWERING BEHAVIOUR IN *CURCUMA CAESIA* (ZINGIBERACEAE)

*(With a text-figure)*

Flowering behaviour (flowering season and position of inflorescence) is a key character in delimitation of *Curcuma* species. Normally, those species that flower in autumn (autumnal) possess central spikes arising from the centre of the leafy tuft while those that flower in summer (vernal) have lateral spikes arising from the lateral buds of rhizome or sessile tubers, before leaf formation.

Normal flowering has been observed in *C. longa, C. decipiens, C. pseudomontana, C. peethapushpa* (section Mesantha) which exhibited autumnal flowering with central spikes and in *C. aromatica, C. zeodaria, C. comosa, C. caesia* (section Exantha) which exhibited vernal flowering with lateral spikes. *C. caesia* (Black zeodary; section Exantha), however, exhibited anomalous flowering behaviour this year by producing both lateral and central spikes within a short span of time during late summer (Fig. 1). Some plants of a population of *C. caesia* grown at Vellanikkara produced lateral spikes initially and a few other plants of the same population produced central spikes after about two weeks.

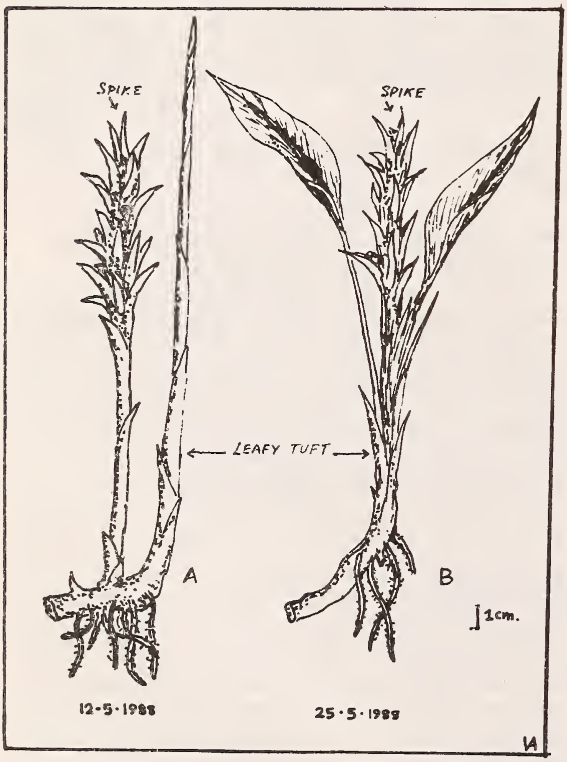

Fig. 1. *Curcuma caesia* exhibiting bothy lateral (A) and central (B) spikes within a short span of 2 weeks.

Santapau (1953) recorded lateral spikes in summer and later, central spike in monsoon from *C. pseudomontana* plant. This type of anomaly has also been reported from another Zingiberaceae plant, *Zingiber officinale* by Velayudhan *et al.* (1983). Such anomalies in the genus *Curcuma* have been a point of great controversy (Manilal and Sivarajan 1982). Past reports on the genus by Santapau (1953 & 1958) and Chavan & Oza (1966) supported the view of Roxburgh (1810) that the flowering spikes' position in *Curcuma* was seasonal and its value as a basic key for species delimitation was doubtful. Lately, Saldhana and Nicolson (1976) had also expressed similar views. However, as noted by Burtt (1972), before deciding the validity of flowering behaviour as a key character for identification, further observations on seasonal flowering behaviour in other species of *Curcum* are needed.

ACKNOLWEDGEMENTS

Grateful thanks are due to Dr R.K. Arora, Director and Shri T.A. Thomas, Head of Evaluation Division, NBPGR, New Delhi, for encouragement and facilities extended

V.A. AMALRAJ
K.C. VELAYUDHAN
December 13, 1988 V.K. MURALIDHARAN

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## 45. *PASPALUM LONGIFOLIUM* ROXB.: A GRASS NEW TO UTTAR PRADESH, INDIA

Recently Mr. Pancham Singh of the Botany Department, D.A.V. (P.G.) College, Dehra Dun, collected a grass from Nakraunda, district, Dehra Dun, which we could not match with any species represented from Uttar Pradesh. The grass was identified as *Paspalaum longifolium*, whose home is principally in northeast India (Bor 1940 & 1960). It has also been reported to occur in Kerala (Fischer 1934), Gujarat (Patil 1965), Madhya Pradesh (Naithani & Raizada 1977) and even outside India. The present paper records for the first time the occurrence of this grass from Uttar Pradesh.

**Paspalum longifolium** Roxb. (Hort. Beng. 7. 1814, *nomen*) Fl. Ind. 1:283. 1820; Hsu, Taiwan Grass. 585. fig. 586. 1975.

A perennial grass. *Culms* 50–125 cm tall; *leaves* 35–80 cm X 4–6 mm. *Inflorescence* a panicle made up of 6–24 false spikes; *spikelets* 4–seriate; *lower glume* absent, the upper obovate-oblong, 3-nerved; lower floret barren; *lemma* 5-nerved; *palea* like lemmas. *Caryopsis* broadly ovate.

*Specimen examined:* Nakraunda, Dehra Dun, 26 Oct. 1986, *Pancham Singh* ex Herb. Som Deva No. 10690 (DD & BSD).

*Distribution*: India (northeast India, Kerala, Gujarat, Madhya Pradesh), Nepal, Sri Lanka to Vietnam, Taiwan, North Australia and Malaysia.

*Ecology*: Solitary or in groups in moist places, e.g. along river banks, in swamps and pools, in floating grass communities, growing in water upto 60 cm deep. A common invader in wet and open, disturbed places. Associated with *Bothriochloa, Echinochloa, Eriocaulon, Miscanthus, Oryza*. On sandy, loamy clayey, alluvial soils, upto 1700 m altitude (De Koning & Sosef 1985).

*Chromosome number*: 2n = 40 (Chen & Hsu 1961).

*Uses*: Some value as fodder grass for buffaloes (Bor 1960).

SOM DEVA
April 9, 1988. H.B. NAITHANI

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| 272 | Left | 11 from above | Wynter-Blyth 1951 | Wynter-Blyth 1957 |
| 272 | Left | 11 from above | Talbot 1934 | Talbot 1939, 1947 |
| 275 | Right | 16 from below | *Hypolimans* | *Hypolimnas* |
| 275 | Right | 16 from below | *missipus* | *misippus* |
| 276 | Left | 13 from above | *Premis* | *Precis* |
| 277 | Left | 13 from above | *violaea* | *violae* |
| 280 | Right | 9 from above | (1939):..... Vol. 2 | (1947):..... Vol. 2 |

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|  |  |  |  |  |
|---|---|---|---|---|
| 443 | Title |  | *monstrous* Drury | *monstrosus* (Drury) |
| 443 | Left | 3 from below | *monstrous* Drury | *monstrosus* (Drury) |
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## NOTES ON THE STATUS AND DISTRIBUTION OF SOME BIRDS IN SRI LANKA

Page 9, Left column
**For** 161. Crested Hawk-Eagle (*Spizaetus cirrhatus andamanensis*)
**Read** 161. Crested Hawk-Eagle (*Spizaetus cirrhatus cirrhatus* )

## MISCELLANEOUS NOTES

### 17. OCCURRENCE OF THE WHITECOLLARED KINGFISHER

Page 105, Left column, Line 12,
**For** Ali & Ripley (1970:406) restricted its distributional range to Camorta, Central Nicobar.
**Read** Ali & Ripley (1970:98) mentioned its occurrence on Car Nicobar, Camorta, Nancowry, Trinkut and throughout the group. Abdulali (1971:406) restricted its distributional range to Camorta, Central Nicobar.

Page 105, Left column, in Table 1,
**For** 2 Females 105, 108
2 Males 104, 109
**Read** 2 Males 105, 108
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# HITHERTO UNREPORTED NEST SITE OF LESSER FLAMINGO *PHOENICONAIAS MINOR* IN THE LITTLE RANN OF KUTCH, GUJARAT[1]

TAEJ MUNDKUR, RISHAD PRAVEZ, SHIVRAJKUMAR KHACHAR AND R.M. NAIK[2]

(*With a plate and a text-figure*)

## INTRODUCTION

The known principal nesting grounds of the Lesser Flamingo *Phoeniconaias minor* are the soda lakes of Natron and Magadi in East Africa, where the birds usually breed between August and October (Brown *et al.* 1982). More recently, in 1978, the bird has been known to breed on the Makgadikgadi salt pans in Botswana, southern Africa (Robertson and Johnson 1980).

The only breeding site "Flamingo City" in India was discovered in January 1974 in the Great Rann of Kutch in Gujarat, where a colony of between 2000 and 5000 birds were found nesting beside Flamingo *Phoenicopterus roseus* (Ali 1974). The main nesting colony in the Great Rann has not been active since 1977; possible reasons are discussed by Thakker (1982) and Kumar (1986). Though there have been no further record of the bird breeding in Gujarat, there have been ample suggestions of its breeding somewhere around. Non-flying juvenile birds were sighted near Navlakhi by S.D. Jadeja, P. Prunes and C. Briggs (pers. comm.) in February 1984. On 23 December 1984, when we saw more than 460 Lesser Flamingo in a saltpan northwest of Jalandar bet in the Little Rann of Kutch, there were 52 flying juveniles and 14 adults in one group. On 27 December 1985, we saw one non-flying juvenile west of Navlakhi. The suspicion has been that the main "Flamingo City" has been abandoned and split up into smaller breeding groups in the Little Rann, Great Rann and possibly elsewhere in the area.

This study reports a hitherto unknown site in Gujarat where the Lesser Flamingo breeds.

## MATERIAL AND METHODS

In connection with our numerous studies in the Gulf of Kutch since September 1984, we often visited Surajbari and Cherwari (Cherowari). While interviewing fishermen there, we learnt about possible nesting of the Lesser Flamingo in a nearby area, which we specially visited on 20 March 1986, 10 June 1986, 19 June 1987, 19 July 1987, 22 June 1988 and 9 July 1988.

## STUDY AREA

The Little Rann of Kutch in Gujarat separates the district of Kutch from Rajkot and Surendranagar districts of the Saurashtra region. National Highway 8B and the broad gauge railway line from Saurashtra pass over two bridges

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built over the mouth of the Little Rann near Surajbari and Malia. Spread over both sides of the railway bridge on the Kutch side, is a seasonal fishing village called Cherwari (Fig. 1). A majority of the fishermen living here are from the nearby village of Surajbari. Cherwari has a landing site for prawn and fish on the north bank of the Hadakiya creek which joins the rann with the Gulf of Kutch. The tidal waters come through the main creek, flow under the bridges and past the village to circulate through anastomosing channels extending 3-4 km into the rann throughout the year. During the pre-monsoon (May and June) and monsoon (July to September), the height of the tidal water increases. Driven by winds, these waters spread further east into the rann. This, augmented by the rain water, fast turns the dry salt encrusted mudflat into damp ground and finally into a shallow marsh. During this period, Cherwari becomes a very important fishing village, and the entire flooded rann is intensively fished for prawns, especially *Metapenaeus kutchensis*

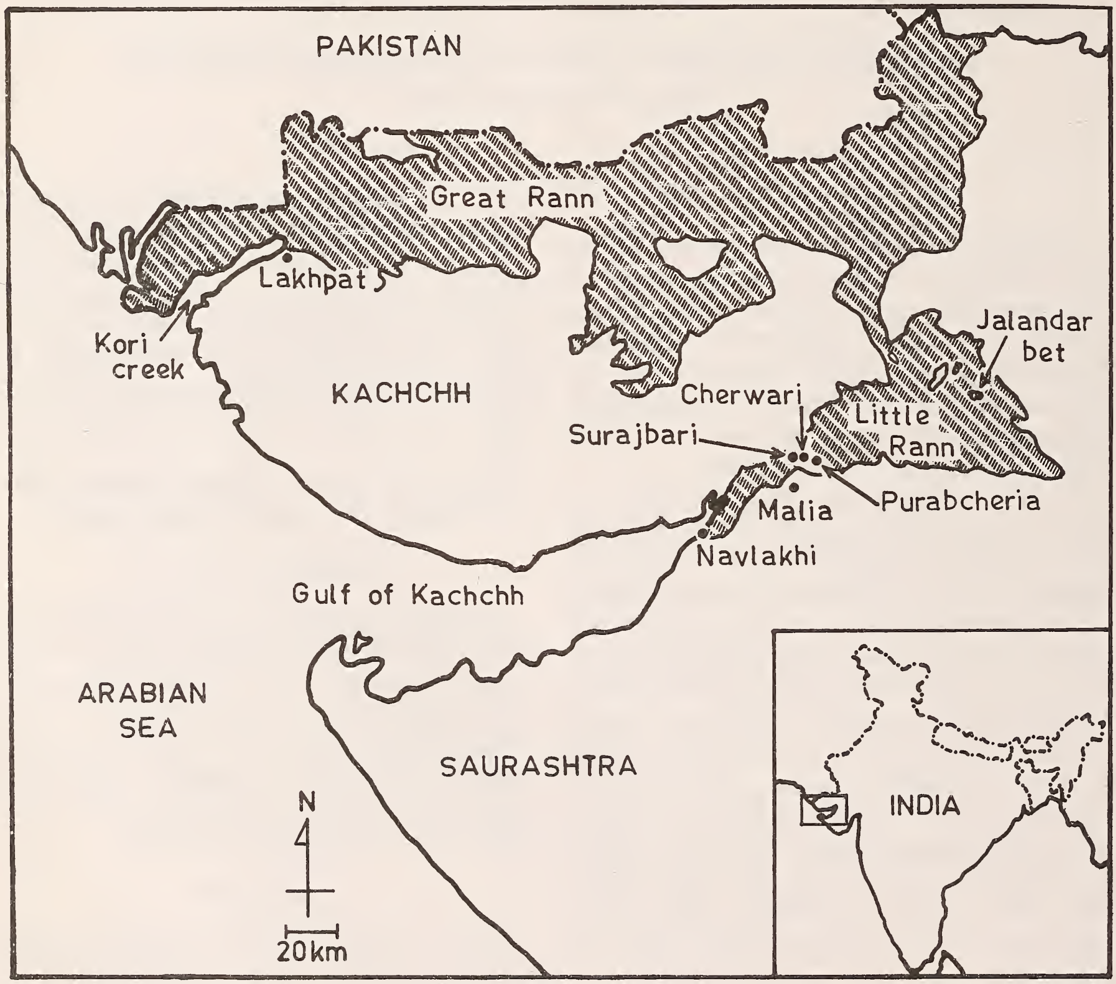

PAKISTAN
Great Rann
Lakhpat
Kori creek
KACHCHH
Cherwari
Surajbari
Little Rann
Jalandar bet
Malia
Purabcheria
Navlakhi
Gulf of Kachchh
ARABIAN SEA
SAURASHTRA
N
20km
INDIA

Fig. 1. Study area in Gujarat. Shaded area indicates Rann of Kutch. Inset shows map of India; rectangle indicates location of study area.

and *M. brevicornis* that abound and grow rapidly in the brackish water.

East of Cherwari, about 3 km into the rann, is a location known as Purabcheria (23°11'N, 70°46'E; Fig. 1); "purab" meaning the direction east, and "cheria" meaning mangrove vegetation, the latter possibly a reference to its past occurrence. Purabcheria is built on a slightly elevated area of silt. At present, the place has a few minor, irregularly placed mounds of mud, up to half a metre in height, overgrown with stands of coarse grass and a few stunted bushes of *Tamarisk* sp.; a little westward, there is a small but prominent stand of grass *Saccharum* sp. According to a fisherman the mounds of Purabcheria were originally produced by piles of mud that were removed while dredging channels by fishermen to bagnet prawns.

## RESULTS

Fishermen of Cherwari revealed to us that at least two generations of fishermen have witnessed the nesting of Lesser Flamingo at Purabcheria. They nest in large numbers, laying a single egg per nest, the nest mound being called a "timbla". They also lay eggs directly on the grass mounds called "tekras". After the eggs are laid, occasionally the water level may rise, inundating the nesting colony. The eggs floating in water are collected and eaten by fishermen. Eggs are also collected from nests, and eaten in large numbers but are not usually sold. Though the birds lay eggs nearly every year, only one man claimed to have seen young ones and eaten them. Fishermen in all the nearby fishing villages from Surajbari to Malia are aware of this colony and have eaten the eggs. The fishermen also kill and eat adult birds when possible, claiming that they walk up to them slowly and then strike at a bird with a long stick. Occasionally, persons from nearby villages, armed with guns, also come here to hunt. However, for the last three years (1985–1987), they have not seen any eggs though the birds have continued to gather here in astounding numbers. In June–July the birds disappear. It is claimed that the birds depart at night.

Since 1986, we visited the study area six times (Table 1). When we visited the area first on 20 March 1986, we saw no nest mounds in the vicinity of the site described above. There was only one Lesser Flamingo at the creekside and the fishermen said that it was too early in the season for the birds. During the visit on 10 June 1986 there were no birds and the fishermen said that the birds had flown off only a few days earlier. On 19 June 1987 when we visited the site again, there were 5 groups of 83 new nests. The total number of nests during our next visit on 19 July 1987 was 288, scattered about in 14 sub-groups in an area of 0.5 sq. km. Most of the groups were built on the edges and banks of narrow (0.5–1.0 m wide) channels (Plate 1). There were no signs of eggs, or remains of chicks in the nests to suggest that egg laying had taken place.

During our June 1987 visit, there were about 16,000 Lesser Flamingo in the area, and there

TABLE 1
SUMMARY OF OBSERVATIONS AT THE BREEDING GROUNDS OF LESSER FLAMINGO AT PURABCHERIA

| Date | No. of birds | No. of nests | Remarks |
|---|---|---|---|
| 20 March 1986 | 1 | 0 | Birds still to arrive. |
| 10 June 1986 | 0 | 0 | Birds migrated about 3 June 1986. |
| 19 June 1987 | 16,000 | 83 | No eggs laid. |
| 19 July 1987 | 2,000 | 288 | No eggs laid, 1 bird on nest, groups attending empty nests. |
| 22 June 1988 | 9,000 | 123 | No eggs laid. |
| 9 July 1988 | 7,000 | 183 | Eggs collected by fishermen. |

were more, seen as a pink hue beyond clear vision on the horizon in the east. Most of the birds were standing and resting, preening and a few sitting on the ground. A few birds were engaged in feeding. During the July visit, the rann was wet, Mudskippers *Periophthalmus* sp. and crabs *Amphiuca inversa sindensis* were active in building their burrows. Further east of the flamingo colony, the land was covered with a sheet of water, this area being very slightly low lying as compared to Purabcheria. The number of Lesser Flamingo had now decreased to about 2000. Flamingo were also present in small numbers. When viewed from far away, small groups of 10–20 birds were seen standing and resting in and around the nests. One bird was actually resting on a nest. On our approach, they walked away to a nearby creek and rested there.

On 22 June 1988, when the site was visited, there were a total of 123 nests but no eggs were seen. The rains started in and around the Little Rann in the first week of July. Thereafter there were widespread rains in the area. Around 5 July, laying started, but the local fishermen collected the eggs immediately, so that on 9 July, except for a single egg in the water, all the nests were empty. One fisherman had a collection of 7 eggs, from which three eggs were taken to the laboratory and were blown. They measured on an average 78.7 x 49.7 mm.

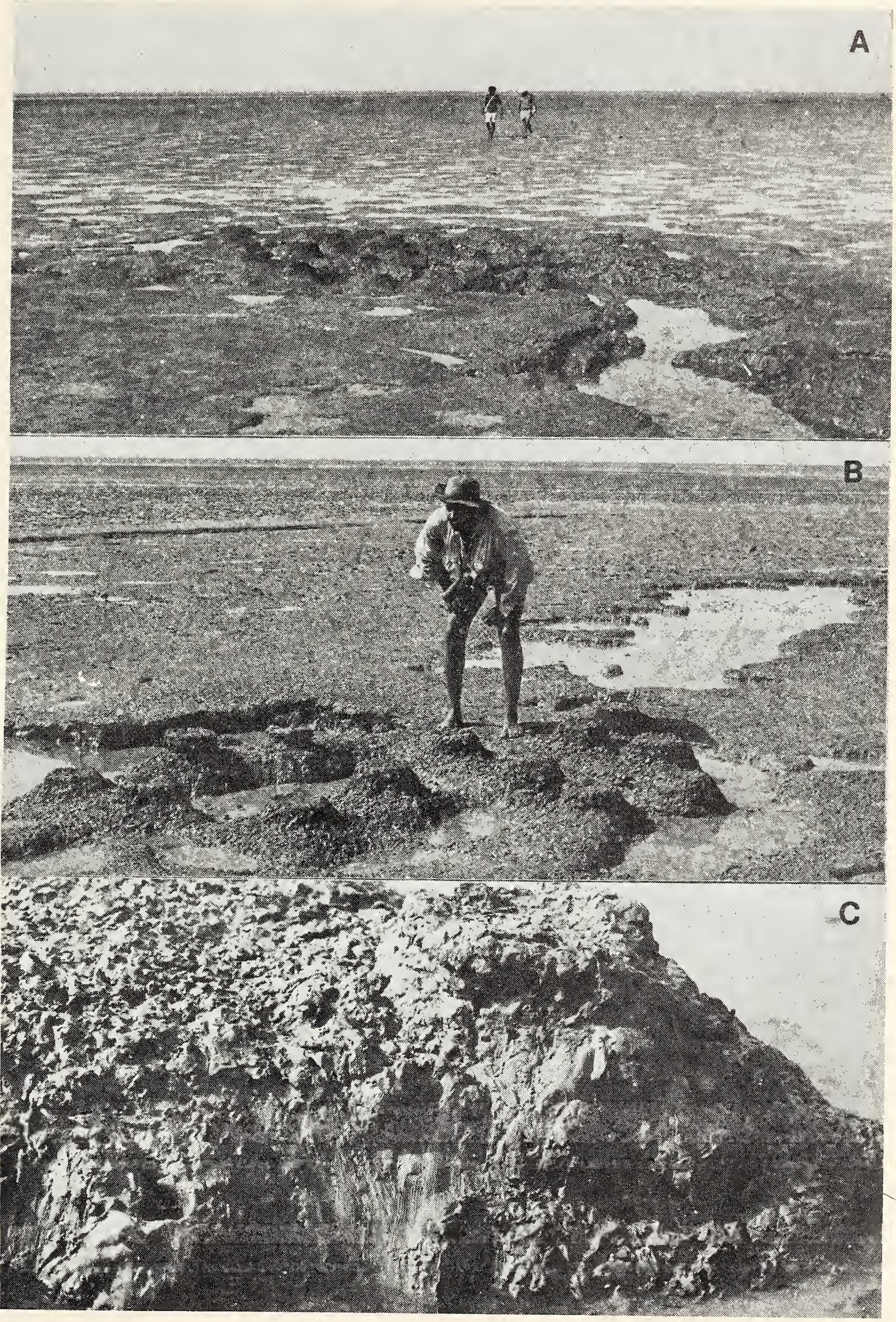
On the last four visits, we saw flocks of birds, upto about 25 in number, walking in a tight flock, heads held up, necks taut and vertical. A few birds would flip their heads down suddenly, so that their bills would come in contact with the necks and then the heads would be lifted up again. After a few steps in one direction the whole group would change direction and continue to shuffle along. While a bird standing nearby would join the group, another would leave it, in no discernible order. This would continue for upto about 10 minutes and then the group would dissolve. Brown (1959) describes a similar courtship behaviour for this bird in East Africa, though there the birds would number a thousand or so in a group and the act would continue for a much longer period.

During our visits to Cherwari and the surrounding area, we saw flamingo flying in small and large flocks to and fro between the rann and the gulf side. They were also arriving from further west. A majority of the birds that flew into the rann landed along the creekside very close to the jetty of Cherwari. They rested here and drank water from the puddles along the creek. The birds were not wary and a fisherman in a boat could approach them fairly close.

## Discussion

A large concentration of the Lesser Flamingo builds up around Cherwari in June–July. At least some of them make a nesting attempt at Purabcheria by building nests. In some years they even lay eggs, but whether the nesting ever succeeds is not clear. It is well known that flamingo desert their colony if disturbed, as they would be by egg collectors. This may be one reason why young have not been seen at the colony. It also seems possible that the chicks migrate *en masse* further east into the shallows of the rann, and develop there out of the view of human beings. In Africa, the chicks are known to march upto 30– 50 km across mudflats to lagoons of permanent water (Brown *et al.* 1982). We feel that Púrabcheria is the westernmost limit of the nesting colony in the rann. When the rann is flooded, a ground survey is not possible. Therefore, activities of the birds east of Purabcheria should be monitored by an aerial survey early during the monsoon every year.

After the monsoon breaks, the birds leave this area in July if the rains are not adequate. In 1986, just after the exodus of the flamingo from here, we happened to be at the north end of the Kori creek (Fig. 1). In the early hours of the morning and then just before dawn on 21 June 1986, flocks of Lesser Flamingo, some of them as many as 300 strong, were flying high and moving towards the northwest direction leading to Pakistan. This is also the general direction along the coast which leads to the known nesting grounds of flamingos—the soda lakes of East Africa. Nesting there



Nests of the Lesser Flamingo in the Little Rann of Kutch. (A) Overall view of a group of nests. (B) Close-up of a few nests built on a channel. (C) A single nest; note the marks (lower centre) of bill of the flamingo made during nest construction.

occurs mainly during August to October, extending upto December in certain conditions (Brown *et al.* 1982).

The proximate factors for nesting in flamingos are imperfectly understood. We feel that the Lesser Flamingo nests in the Little Rann during the early monsoon in years of normal rainfall. The insufficient rainfall during 1985, 1986 and 1987 seasons was correlated with the failure of birds to lay eggs at Purabcheria. Adequate rains increase the supply of invertebrates, microscopic algae and benthic diatoms, which may provide the flamingo with additional energy required for egg formation. Because of the drought in the coastal areas, an increasing number of human beings visited Purabcheria to cut grass to feed their domestic livestock; we have observed as many as 20 people from the Hangiasar village on the southern side of the rann, coming here to cut grass. In East Africa, the birds do not breed every year even when the climatic conditions and state of the breeding site seem suitable (Brown and Root 1971).

In India, there is no information on the nesting season of the Lesser Flamingo as there was only one record (Ali 1974) of it breeding here. From observations at Purabcheria, it seems that the nest building and egg laying occur with the onset of the monsoon. However, Ali (1974) found nests with eggs and chicks in January. It, therefore, seems likely that the season here is variable depending on the conditions of water; it begins in June—July and extends up to January—February. Considering that the young birds are known to fly by the age of 70–75 days (Brown *et al.* 1982), the observations of non–flying young near Navlakhi in February and December 1984 indicate that around December 1983 and October 1984 (see above), nesting had taken place somewhere in the Rann of Kutch.

## ACKNOWLEDGEMENTS

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# A STUDY OF *VARANUS FLAVESCENS* (HARDWICKE & GRAY) (SAURIA: VARANIDAE)[1]

WALTER AUFFENBERG[2], HAFIZUR RAHMAN, FEHMIDA IFFAT
AND ZAHIDA PERVEEN[3]

(*With ten text-figures*)

The present study documents several aspects of the biology of *Varanus flavescens.* Adequate available material now makes possible a more detailed description of the morphological features of this species than was previously possible. The annual reproductive and abdominal fat cycles are outlined and the common prey organisms identified. The primary habitat is shown to be mesic to hydric wet savannas and marshlands. The geographic range is defined and the suggestion made that though the species is widely distributed in the Indo- Gangetic Plain, it tends to be spotty. These and other factors lead the authors to consider this the most endangered of all Asian mainland monitors.

## INTRODUCTION

This study was undertaken because of all varanid species of mainland Asia, *Varanus flavescens* is one of the poorest known. It is, in addition, surrounded with considerable controversy and mis-information.

The following data were obtained from 1984 through most of 1987, in Bangladesh, India and Pakistan. Additionally, important museum specimens were examined in these countries as well as in Europe and the United States. Total field time was approximately 18 months (India 10, Pakistan 7, Bangladesh 1). Data were obtained from 185 specimens (134 in museums and 51 in the field). All measurements of total length (TOL), tail length (TL) and snout-vent length (SVL) were made to the closest mm; all internal measurements (testes, ova, etc.) were made to the closest 0.1 mm; all weights to the closest 0.1 g.

## SYSTEMATICS

**Synonomy:** Because of the confusion on the part of some biologists concerning the current valid name for this species, the following annotated synonymy of previous name combinations used for this species is provided.

**Varanus flavescens** (Hardwicke & Gray)

1827: *Monitor flavescens* Hardwicke and Gray, p. 226, type locality "India". First species description.

1830: *Varanus russellii* Heyden (in Ruppell), p. 23, type locality Bengal. First reference to any locality at the provincial level.

1836: *Varanus picquotii* Dumeril and Bibron, p. 485, pl. 35, fig. 5, type locality Bengal.

1838: *Empagusia flavescens* Gray, p. 393. first use of *Empagusia* (now used as a subgenus, Mertens 1942).

1844: *Monitor exanthematicus indicus* Schlegel (not *Tupinambis indicus* Daudin 1802), p. X, type locality Bengal. First association with the African species *Varanus exanthematicus.*

1847: *Varanus flavescens* Cantor, p. 634. First use of the current valid name combination.

1942: *Varanus (Empagusia) flavescens* Mertens, p. 347, pls. 1, 16, figs. 4, 110. First use of *Empagusia* as a subgenus.

For reasons given below the type locality is here restricted to Calcutta, West Bengal, India, to replace "India" as used by the original describers Hardwicke and Gray (1827).

**Phylogeny:** *Varanus flavescens* is characterized among other features by the fact that its external nares are slit-like in shape, located closer to the tip of the snout than to the eyes (Fig. 1), with a skull that is high in proportion to its length (Fig. 1) and with body scales relatively large when

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[3] All remaining authors Zoological Survey Dept., Block 61, Pakistan Secretariat, Karachi 1, Pakistan.

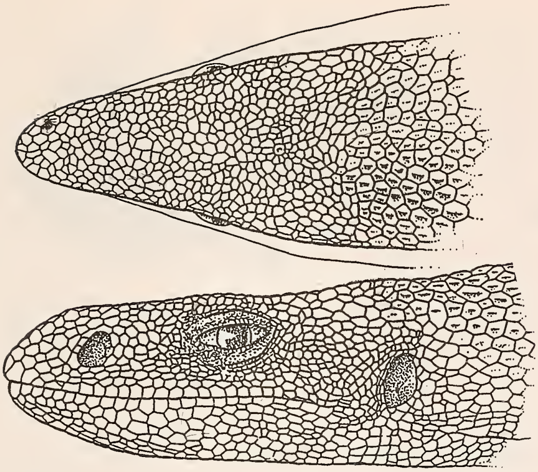

**Fig. 1. Head shape and scalation in *Varanus flavescens*, Dokri, Larkana District, Sind Province, Pakistan.**

compared to those of most other monitors. This combination of characters is found in the African savanna monitor *Varanus exanthematicus* (Bosc), leading to Schegel's conclusion that *V. flavescens* (as *Monitor indicus*) was a subspecies of *V. exanthematicus*. This concept of probable close relationship was furthered by Gray's placement of both species in the genus *Empagusia*, erected specially to receive these two species with similar characterstics (though the nostril of *V. exanthematicus* is located much closer to the eye). In 1942 Mertens also concluded these two species were closely related on the basis of skull and jaw structure (particularly the form of the skull and the length height index of the maxillary). He placed both species in the subgenus *Empagusia* – one of seven he established at that time. In 1959 he redescribed the skull of *V. flavescens* on the basis of better material then at hand, adding other characters to those he formerly believed showed relationship to *V. exanthematicus* (supratemporal process of the parietal and the basipterygoid process). He also noted several characters by which these species differed from one another and suggested that *V. flavescens* was the more primitive type from which *V. exanthematicus* evolved.

The studies of Singh *et al.* (1970) introduced new diagnostic characters for *V. flavescens* in which chromosomal morphology played a major role in defining relationships. However, the limited number of species compared and the absence of details important in comparison of *V. flavescens* with other varanid species (ill-defined centromere location and poor resolution) limited the usefulness of these new data in determining the phyletic position of this species. King and King (1975) improved the utility of such data by employing both short-term leucocyte culturing techniques on whole blood and better staining procedures. This resulted in higher resolution and precise centromere location. Their examination of 16 of the 32 congeners showed that these could be placed in six distinct karyotype groups. Not all of these corresponded to current taxonomic groupings. Among these differences were the species *V. exanthematicus* and *V. flavescens*, which failed to assort themselves into a single group. The former was suggested as being more closely related to *V. niloticus* (continental Africa) than to *V. flavescens*, which was closer to its sympatric congener *V. bengalensis*. These studies thus cast considerable doubt on the validity of the subgenus *Empagusia* as currently recognized and suggested that further work was needed before the phyletic relationships of *V. flavescens* could be ascertained. The studies by Holmes, *et al.* (1975) on comparative electrophoretic data tended to substantiate the groupings suggested by the work of King and King on chromosomal morphology, though *V. flavescens* was not included in their list of species examined. However, the study provided additional substantive data to the developing notion that the Mertensian system of varanid relationships may be somewhat incorrect.

Even more recently, Bohme (1982) and Branch (1982) independently concluded that *V. flavescens* and *V. exanthematicus* are only distantly related on the basis of hemipenial morphology. The penial morphology of *V. flavescens* was shown to be more primitive than that of *V. exanthematicus*.

Collectively, the conclusions resulting from this recent work are: 1) the earlier contention of monophyly among living varanids is still valid, 2) *V. salvator* possessed less derived (i.e. more

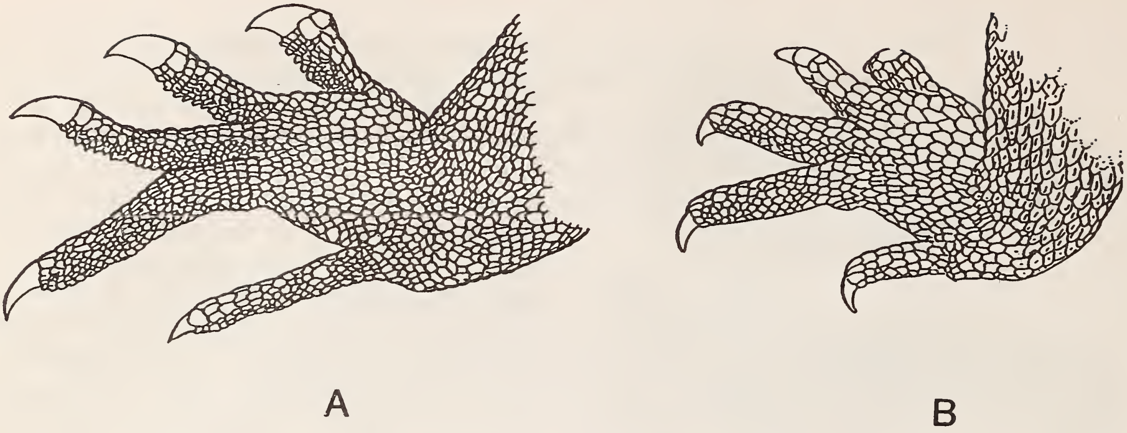

**Fig. 2. Hind feet of varanid lizards. A, *V. bengalensis*; B, *V. flavescens*.**

primitive) characters than all other species, 3) interspecific relationships among the species included in the genus are less clear than previously believed, 4) while some subgeneric groupings are easily diagnosed on the basis of chromosomes, proteins and morphology, others are not, 5) *V. flavescens* is not as closely related to *V. exanthematicus* as once thought, and that what characters are similar are probably due to convergence, 6) this species is a fairly primitive one, with closest relationships to *V. bengalensis*, *V. rudicollis*, *V. salvator* and (by extension, see Auffenberg 1987) *V. olivaceous*. However, the skull shape and construction (which led Mertens to place it close to *V. exanthematicus* to begin with), short, stubby toes (Fig. 2, found only in *V. griseus* among other mainland Asian species) and certain parasitic relationships and behavioural traits (see below) suggest that it should continue to receive separate nomenclatorial status at the subgeneric level. Thus we favour the retention of the subgeneric concept as applied to *V. flavescens*, placing it (by priority) in *Empagusia* as its sole member. It is very likely that additional study of other characters will throw other light on its relations to other *Varanus* species and that a thorough cladistic approach to the problem of varanid phylogeny would yield new and important insights into this matter.

## MORPHOLOGY

A description of the skull anatomy and scalation of *Varanus flavescens* is provided by Mertens (1942, 1959), though based on only 7 specimens, of which only three are provided with locality data (all West Bengal, India). Thus the many additional specimens now available from several widely scattered localities and which we have examined during the course of this study suggest we address the matter of potentially significant geographic, sexual and ontogenetic variation in this species. Of these, the most cogent pertain to scalation, bodily proportions and colour pattern. Some of the variation has been the basis for mis-identification of *V. bengalensis* as *V. flavescens* in the past. (Biswas and Kar have transposed the photographs and legends for *V. flavescens* and *V. salvator*).

The following descriptions and discussion are based on 185 specimens.

**Size and Mass:** Compared to other Asian monitor species, *Varanus flavescens* is a rather small species, (only *V. griseus* has a smalller average adult size; W.A. notes). In spite of the fact that we examined a large number of individuals in the field and in museums, the specimen cited by Boulenger (1885) is still the largest reported (TOL 920 mm, SVL 410, TL 510). Visser (1985) reports a newly hatched young with TOL 145 mm, SVL 66, TL 79; those neonates examined by us in the field (all from India) varied from TOL 143–

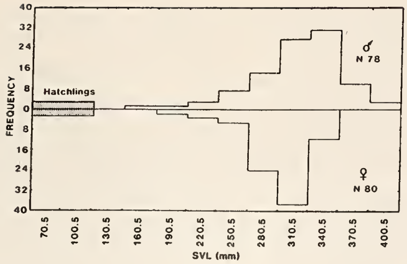

Fig. 3. Frequency of size classes in *V. flavescens*, all localities combined.

188 mm, SVL 64–92, TL 78–96; means of all hatchlings for which such data are available (N 18) are $\bar{X}$ TOL 163.3 mm, $\bar{X}$ SVL 77.6, $\bar{X}$ TL 85.7. Mean TOL for all non-hatchlings (N 167) is 699.5 mm, $\bar{X}$ SVL 315.1, $\bar{X}$ TL 384.4. There is no significant difference between size of individuals in populations from the Ganges (N 50) and Indus (N 117) river valleys. Tail length is relatively short when compared to other monitor species, varying from 1.2–1.3 times the SVL ($\bar{X}$ 1.27), with the relationship being linear and expressed by the formula tail length = $1.27^x$ SVL–18.55 ($R^2 = 0.83$). There is no significant change in proportionate tail length with age, as in some other monitor species (Mertens 1942, Auffenberg 1982). There is slight, but significant difference in mean SVL (Fig. 3) of males (342.0 mm, N=55) and females (332.2 mm, N=47) ($t = 2.88$, DF 100, $p > 0.02$). The small difference is rather unusual in varanids, for in almost all species studied males are significantly larger than females. This fact must be of considerable importance in *V. flavescens* reproductive behaviour, for in the courtship of all other varanids studied (Auffenberg 1983, 1987), the larger males of those species tend to completely dominate the smaller females. The fact that both sexes of *V. flavescens* are similar in size suggests that their reproductive behaviour may be quite different from that reported for other *Varanus* species. We assume that male dominant behaviour is less marked in this species during courtship. This may, in turn, be related to the seasonal change in body coloration during the reproductive season of adults (see below).

The weight of 83 adult individuals varied from 510 to 1040 g, $\bar{X}$ = 768.5 g ($SD^{\pm}$ 154.6, V = 20.1); no weights are yet available for hatchlings.

**Proportions:** That the tail length does not change ontogenetically in length in proportion to the body and head (SVL) has been shown above.

The slit-shaped nostril is placed closer to the snout than to the eye (Fig. 1) with the ratio of snout-nostril length/snout to ear (anterior edge) length varying from 0.21 to 0.28, $\bar{X}$ = 0.25. We find no significant geographic or ontogenetic variation in nostril position.

The toes of particularly the hind feet of this species are short and the claws relatively straight (both mentioned by Mertens 1942) when compared to congeners (except *V. griseus*) (Fig. 2). Its short toes were noted as early as 1884 by Murray, who called this species the ''short-toed water lizard''. The length of the hind foot along the longest toe (number IV) is usually 14 percent of the SVL in individuals of all sizes. Toe IV of the congeneric *V. bengalensis* is much longer (Fig. 2).

**Viscera:** The absence of a caecum at the beginning of the large intestine is a common feature of faunivorous invertebrates (Hladik 1976). It is essentially completely missing in the carnivorous *V. salvator*(Auffenberg 1987), only very slightly developed in the largely insectivorous *V. bengalensis* (Auffenberg MS) and very well developed in the frugo-molluscovore *V. olivaceus* (Auffenberg 1987). In other vertebrate animals a caecum is often associated with herbivory. Thus we were quite surprised to find a somewhat enlarged area at the anterior end of the large intestine, supplied with abundant blood vessels that could be described as a developed caecal pouch. Why this should occur in a completely faunivorous varanid (see below) remains unknown.

Calculation of the internal surface area (A = 2 pi rh) of the stomach, small and large intestine of *V. flavescens* (following the techniques suggested by Chivers and Hladik 1980) shows that the surface area of the stomach is the greatest of the three intestinal sections (7854.0 mm$^2$), as expected in a carnivore (Hladik 1976). The large intestine is the next largest (6141.8 mm $^2$), and the small intestine possesses the least surface area. The area of the stomach surface and that of the large intestine relative to the area of the small intestine provides a quantitative index of gut differentiation (Coef. Gut Diff.: stomach area + large intestine area/small intestine area; see Chivers and Hladik 1980 for justification, etc.). In *V. flavescens* the area index is 2.79. This value is higher than those values obtained for the only other varanids studied (Auffenberg 1987; values 2.24 and 2.42 for *V. olivaceus* and *V. salvator* respectively). The larger value in *V. flavescens* is primarily due to the proportionately smaller small intestine. Since most absorption takes place in this part of the gut (on the basis of its rich blood vessel supply), we assume that the food of this species must be nutritionally rich and probably much more easily digested than that of the other two species studied previously, which have proportionately longer small intestines.

The liver of 100 individuals was weighed and this compared to total animal weight for different months of the year. The results show that there is no difference in liver weight in males and females, but a significant seasonal change in which liver weight is low in August and September, but high in December through April. The latter months are those of least activity on the part of the lizards and the former are the months following courtship and breeding and during the monsoon. During the monsoon (mid-July through mid-September, depending on locality), liver weight varies from 1.4 to 3.4 % of total body weight (N 31); during the winter (December through March) liver weight varies from 3.3 to 7.7 % (N 34). The mean liver weights for these periods ($\overline{X}$ = 2.6, SD 0.7, and $\overline{X}$ = 4.6, SD 1.1 respectively) are significantly different at the 0.001 % level ($t$ = 129.2, df 70).

As far as is known, liver function in reptiles is probably identical to that in mammals. Its main roles are concerned with protein, cholesterol and bile salt synthesis, glycogen storage, and metabolism of steroid hormones. From a dietary standpoint, the liver is most important in fat degradation and detoxification of a number of proteinaceous substances. In general, larger livers have been viewed to result from greater systematic levels of hepatotoxins and greater variation in chemicals being metabolized (see Freeland and Janzen 1974, Swain 1976, for general reviews). However, the pattern of seasonal liver weight variation in *V. flavescens* suggests that glycogen storage may also be a major factor in liver size. During the monsoon, food is, in general, the most abundant in the entire year, but this is also the time of greatest activity; winter is the time of least activity.

While seasonal differences in liver weight may be due largely to glycogen storage, interspecies weight differences may be related to dietary differences. In *V. flavescens*, the liver is a large organ, being on average 3.3 % of the total body weight. This compares to only 1.9 % in *V. olivaceus* and 2.6 % in *V. salvator* (Auffenberg 1987). Differences between these and *V. flavescens* are significant at the 0.02 % level (df = 271). In *V. bengalensis* mean liver weight is 2.3 % of total weight, and in *V. griseus* 2.9 %. Differences between these species and *V. flavescens* are not statistically significant ($t$ = 55.8, df 46; $t$ = 38.6, df 116 respectively. Thus the data gathered so far on proportionate liver weight of varanids suggests that the highly selective frugo-molluscovore *V. olivaceus* is much less exposed to high toxin levels than the generalist carnivore species such as *V. flavescens* (see below).

One of the major distinguishing features of this species is the oval nostril that is placed closer to the tip of the snout than to the eye (in *V. salvator* it is rounded, near the snout tip; in *V. griseus* it is slit-like and very close to the eye, and in *V. bengalensis* it is slit-like and placed about midway between the snout tip and the eye). The distance between the snout tip and anterior edge of the nostril in *V. flavescens* goes into the distance from the snout tip to the anterior edge of the tympanum opening from 3.50 to 5.49 times, with a mean of 4.35 (SD 0.41). Fig.1 shows the normal shape of the nostril and its position in respect to the various parts of the head. The same illustration also shows the characteristic shape of the head of this species in side view. With the exception of *V. exanthematicus, V. flavescens* has the highest skull in proportion to its length than any of its congeners. In addition, the lower jaw is generally more robust than in the other species.

**Visceral Fat:** In all lizards in which fat deposits have been studied (see Fox 1977), accumulation of fat in the tail is always indicative of high food abundance. However, fat bodies in the visceral area have been associated with both food supply and reproduction. Volsoe (1944) suggested that visceral fat served as a food reserve in the snake *Vipera berus.* Presst (1971) and Bellairs (1970) extended this to all snakes, pointing out that seasonally small fat bodies were correlated with food shortages. However, in lizards the correlation between fat body size and food abundance is less clear. Hahn and Tinkle (1965), plus several other authors that have followed them, showed that in at least some female iguanid lizards visceral fat is important in follicular development. Bellairs (1970) and Burrage (1975) have suggested that visceral fat may be used by the developing embryos in some lizard species. To complicate matters even more, Fox (1977) demonstrated that seasonal breeders have fat bodies, while year-round breeders do not. However, a study of ten sympatric skink species in tropical evergreen forests of the Philippines suggests a less definite association with annual breeding pattern and a better correlation with seasonal food abundance within the microhabitats of each of the species studied (Auffenberg and Auffenberg 1987). Not all female lizards possess visceral fat bodies, and none of the current explanations clarify the presence of such bodies in males, suggesting that several factors may be responsible for their presence, absence, or seasonal size in lizards.

Visceral fat bodies have been demonstrated in several varanid species (see Auffenberg 1987 for review), but extensively studied in only a few. The general conclusion is that all varanids possess such bodies. This study shows that adult *Varanus flavescens* have them. However, they are very small or absent in all individuals less than 200 mm SVL (0– 0.2 % of total body weight). Thus, extensive body fat deposition (which varies seasonally) is a characteristic of adults only (suggesting a reproductive importance).

In adult *V. flavescens* these deposits may comprise as much as 16.9 % of the total body weight during at least part of the year (OR 0.15–10.9 %). The mean fat weight of all adult specimens examined (N = 70) is 3.8, SD 2.5 % of total weight. This is a greater amount than has been demonstrated for any varanid species studied so far (Auffenberg 1987). *V. flavescens* also occurs in the most seasonally variable environment of any species studied so far (see below).

There is no clear relationship between adult total weight and fat weight ($R^2 = 0.58$), due largely to the considerable variation of fat present. This variation has both an individual and seasonal component, though the latter is dominant. Fig.4 shows that the pattern of seasonal variation in fat weight is identical in male and female adult individuals. The highest values (corrected for adult weight) are found from about December through March in both sexes ($\overline{X}$ = 5.97 % of total body weight). From April to about June proportionate fat weight is reduced. The lowest levels occur from July through October ($\overline{X}$ = 1.08 %). During November there is a dramatic increase in the amount of visceral fat accumulated, leading to the high winter levels.

The values for males and females are nearly identical for almost all months. Thus the pattern differs from that in *V. olivaceus*, in which males have significantly more fat than females during some months (Auffenberg 1987). Since an identical annual pattern with identical values occurs in males as well as females, we assume that abdominal fat deposition in *V. flavescens* is not related to the yolking of ova (as in some iguanids at least), but is probably related to seasonal food abundance (as has been suggested in other varanids; Auffenberg 1987). The period of low fat weight in *V. flavescens* (Pakistan and northern India populations) from July through October occurs during the monsoon in this part of the species

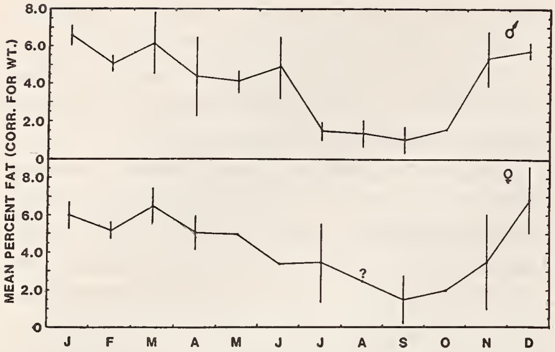

Fig. 4. Annual pattern of visceral fat in adult male and female *V. flavescens* from Dokri, Pakistan.

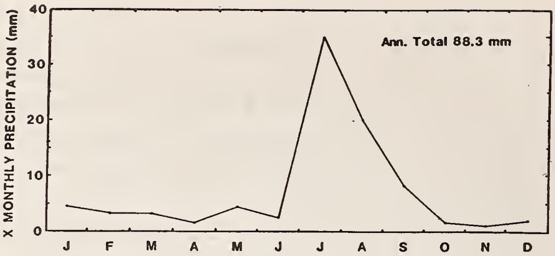

Fig. 5. Monthly precipitation in Larkana District, Pakistan. Estimated totals extrapolated from data provided by Pakistan meteriological Dept.

range, when extensive flooding is an annual occurrence in the river flood plain marshlands where this monitor species is most common (see below). Fig.5 shows the annual rainfall pattern near the Dokri (Pakistan) *V. flavescens* population.

**Scalation:** Very few data are available on the scale characters of this species. The availability of a large number of specimens from throughout the species range suggests we take this opportunity to tabulate those scale characters in *V. flavescens* which are known to be of importance in defining this and other Asian monitor lizard species Several earlier authors have drawn attention to the much larger and heavily keeled scales of *V. flavescens* when compared to those of the other species of the Indian subcontinent. This is easily seen particularly on the dorsal surface. Keeled scales also occur on the dorsal surfaces of both hind and front legs, extending to near the feet (Fig. 2). Scales around the midbody vary from 84 to 104, X̄ 95.5 (SD 4.3). The ventral longitudinal scales from the gular fold to the insertion of the hind limb vary from 68 to 85, X̄ (Pakistan) 75.1 (SD 3.9). In general, the head scales are rather small when compared to most congeners. There are no enlarged supraoculars as occur in *V. bengalensis* from the eastern parts of its range (= *V. b. nebulosus*). The number of scales from the angle of the mouth on one side to the angle on the other side range from 42 to 53, mean 48.5 (SD 2.8); infralabials 23 to 31, X̄ 25.5 (SD 2.5) and suboculars three to four, usually the former. Head scalation is shown in Fig.1.

## COLOUR

As in most *Varanus* species, hatchling *Varanus flavescens* are more vividly coloured than the adults. In general, they are easily distinguished from those of *V. griseus* by having transverse rows of fused yellow spots on a dark background, rather than a few dark bands on a distinctly light-coloured background; *V. salvator* hatchlings have transverse bands of separated yellow ocelli; and those of *V. bengalensis* usually have transverse bands of separated yellowish ocelli and small black dots on a brownish background. Visser (1985) provides a coloured photograph of a hatchling *V. flavescens*.

Adult *V. flavescens* are often confused with adult *V. bengalensis*. This is due largely to the great variation in colour and pattern found in the former. Even within a single population, there is considerable variation among adults of more or less equal size (Fig. 6). While the fused light transverse bars on the body are always present, they vary in transverse length (1–23 scales, X 5.57) and number between the front and hind legs (5–10, X̄ 7.38). The background colour and pattern is even more variable. It may be uniformly black (rare), or the black pigment may form a reticulate pattern, often with a central dot, forming large (often faint) ocelli over much of the body. When little melanin is present the ground colour may be dark to light brown, with only the

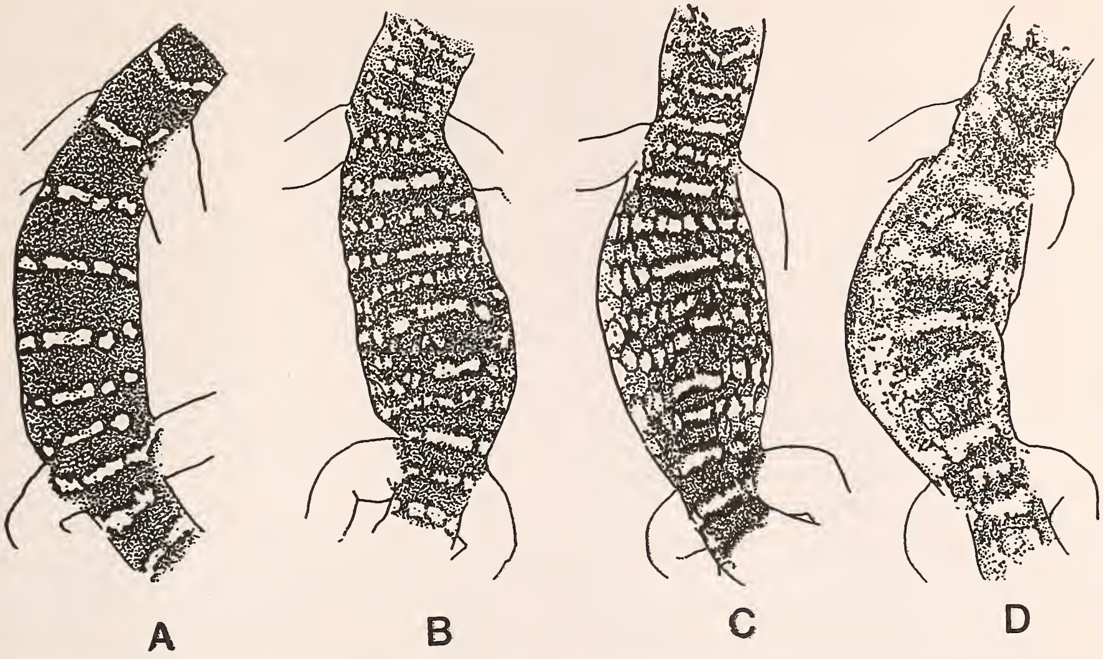

**Fig. 6. Pattern variation in adult *V. flavescens* from Dokri Pakistan, based on transparencies. A, W.A. field no. 148/87; B W.A. 51/87; C, W.A. 109/87; D, W.A. 114/87.**

transverse bands of fused yellow spots edged in black. Many individuals have a suffusion of brownish red to deep red mid-dorsally between the yellow transverse markings and the dark body bands may be suffused with brick red to orange (somewhat seasonal, see below). These lateral dark bands continue onto the ventral surface, though they never meet at the midline. The throat is almost always provided with several black, posteriorly directed V's. In certain seasons the throat may be suffused with yellow to orange. No other Asian monitor lizards possess any orange to red colour on the dorsal or ventral body surfaces.

d'Abreu (1932) reported that adult colour of *Varanus flavescens* from Bihar changed seasonally, the darker body bands purportedly becoming brick red during the monsoon season. Until this study, no material representing appropriate seasonal coverage was available to verify his statements. We were able to examine a minimum of five adult individuals each month during an entire year from a single population at Dokri, Sind Province, Pakistan. This enabled us to establish the type and degree of seasonal colour change occurring in this species. Our conclusions are that colour changes of the type described by d'Abreu (1) do occur, (2) in adults (only) of both sexes, and (3) in populations (probably all) outside of Bihar, India.

These results were based on defining each specimen as possessing one of three categories of orange-red suffusion on the body (0 none, 1 slight, 2 considerable). Analysis of these data show that an intermediate category of orange-red colour suffusion occurs in at least some individuals most months of the year (range in character state 0.09–1.86). The least suffusion is found in October (0.09), following egg laying in females and testes size decrease in September. During most of the remainder of the year the suffusion remains near the mean value of 0.75. However, concomitant with increase in testes size and the beginning of follicular ripening, there is a dramatic increase in the pigment (both sexes) from April to May

TABLE 1

SIZE (MM) AND WEIGHT (G) OF OVARIAN FOLLICLES AND OVARY (ONE ONLY) IN *Varanus Flavescens* (DOKRI, PAKISTAN POPULATION)

| | XN ova | Follicle Dia. (mm)[1] | | Ovary Wt. (g) | |
|---|---|---|---|---|---|
| | <4 mm | X | OR | X | OR |
| Jan. | 0 | None | None | 0.6 | 0.5–0.7 |
| Feb. | 0 | None | None | 0.9 | 0.6–1.0 |
| Mar. | 0 | None | None | 0.7 | 0.5–1.0 |
| Apr. | 0 | None | None | 0.7 | 0.5–0.9 |
| May | 6.1 | 4.7 | <4.0–6.2 | 0.9 | |
| Jun. | 15.0 | 4.8 | <4.0–6.4 | 1.0 | 0.6–1.3 |
| Jul. | 25.3 | 5.7 | <4.0–10.8 | 2.1 | 3.0–6.3 |
| Aug. | 18.2 | 9.5 | <4.0–15.5 | 14.8 | 0.4–48.0 |
| Sep. | 22.6 | 9.2 | <4.0–15.0 | 8.6 | 0.2–31.9 |
| Oct. | 10.3 | 8.9 | <4.0–10.6 | 3.7 | 0.2–40.0 |
| Nov. | 13.1 | 5.6 | <4.0–6.1 | 0.7 | 0.1–1.3 |
| Dec. | 6.3 | None | None | 0.6 | 0.6–0.6 |

[1] Only follicles greater or equal to 4 mm diameter.

(1.86). This remains high through June and July (1.80 for both months), thence dropping regularly through August and September to the lowest values of the year in October again. Individuals that are not sexually mature lack this seasonal colour change. Thus the suffusion is definitely correlated with the development of seasonally important reproductive tissues in mature individuals of both sexes and probably under hormonal control. *Varanus flavescens* is the only species of monitor lizard in which a seasonal colour change has been demonstrated.

## REPRODUCTION

Compared to that for many other lizard families, information on varanid reproduction is scanty. While none of the reproductive data gathered for *Varanus flavescens* are considered complete, the combination of field observations, discussions with local commercial hunters and dissection of a significant number of specimens has provided an ample information base from at which at least the broad outlines of this species reproductive biology can be deduced.

**Sexual Maturity:** The testes weight, length, diameter and volume (estimated from formula for an ovoid) were determined for all individuals of *V. flavescens* dissected. These data show that males less than 260 mm SVL are rarely sexually mature. Enlarged, eventually yolked ova, corpora lutea and ovarian follicles greater than 5 mm occur only in females with SVL over 250 mm and a weight of about 300 g. Females in this reproductive stage represent 85 % of the total female sample during the breeding season. The smallest female that either laid eggs in captivity or had eggs in the oviduct was 295 mm SVL. The minimum SVL of females at maturity is 61 percent of the greatest size recorded in the female sample. This is more or less equivalent to the same statistic in *V. olivaceus* (74 %), but considerably more than in giant *V. komodoensis* (30 %) (data from Auffenberg 1981, 1987). This suggests that growth is maintained for a shorter period of time after sexual maturity in *V. flavescens* than for those few varanid species for which such data are currently available.

*In vitro* staining of the bones of six individuals with tetracycline (see Hutton 1986 for technique description) shows that both females and males of *V. flavescens* become sexually mature during their third year of life. Visser (1985) reports that hatch lings raised in captivity under optimum feeding conditions became sexually mature in three and a half years. This compares favourably with data for *V. bengalensis* in the same geographic area (Auffenberg notes) and is intermediate between the smallest varanid species (mature at end of first year, King and Rhodes 1982), and the largest (*V. komodoensis*, 5–6 years. Auffenberg 1981).

**Female Reproductive Cycle:** To date, the only complete studies of the female reproductive cycle of varanid lizards is that on *Varanus bengalensis* in northern India by Jacob and Ramaswami (1976) and on *V. olivaceus* in the Philippine Islands (Auffenberg 1987). Both investigations suggest that most females lay a single clutch of eggs each year; the current study on *V. flavescens* suggests the same.

Variation in mean monthly volume of female reproductive tissues in *V. flavescens* (one ovary only, Table 1) reflects the progress of follicular development and ovulation. Ovarian tissue volumes are least from November through May (regressed, phase), followed by a dramatic increase in June through July, due largely to yolk deposition. Ovarian tissue volume remains high during August, but drops in September, when undeveloped follicles begin to deteriorate. This volume is slightly increased November to December, when new follicles enlarge, beginning the annual cycle of the following year. The ovarian weight of females examined after completion of vitellogenesis, but before oviposition, is about eight times as great in those females that had oviposited but not yet initiated growth of the next follicle crop. Corpora lutea, formed in the ovary after ovulation, are bright orange-yellow and flattened, with a longitudinal groove on one side. Early in the cycle, those follicles that develop into yolked ova exhibit a colour change from translucent milky-white to pale yellow, becoming more distinctly yellow as more yolk is accumulated. Each ovum weighs about 5 g when ovulated and has a diameter of about 20 mm. One female was preserved just during ovulation, with 10 ova still in the ovary, four already having been received into the oviducts (2+2). The oviductal infundibulae were greatly expanded to receive the ova released from the ovaries, but we saw no evidence that it had stretched over the ovary, as has been claimed for some lizards.

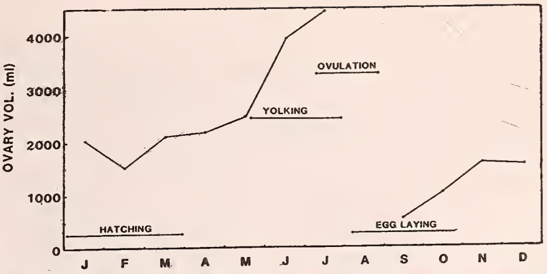

**Fig. 7. The annual pattern of changing ovary volume in adult female *V. flavescens* from Dokri, Pakistan. Timing of the other major phases of the reproductive cycle are also shown.**

The earliest and latest dates for shelled oviductal and oviposited eggs in our study (freshly caught females) are 2 August and 7 October. Visser (1985) reports oviposition in a captive female in a European zoo on 21 July—very close to the earliest date we record in the wild.

During the resting stage the oviductal chamber is straight and parallel-sided. However, at the height of the reproductive cycle it becomes thick-walled, convoluted, and develops the enlarged infundibulum mentioned above. The day following oviposition the oviduct is distinctly stretched in those areas where the shelled eggs were located previously, and where the tissue remains much deeper pink than adjacent oviductal tissues. Most mature females retain evidence of stretched oviductal regions until at least December.

The ovarian follicles of each female dissected were measured. Monthly averages and ranges are shown in Table 1. The trend obviously follows that of ovarian volumes, for yolk deposition in the ova is the greatest contributor to this weight. Though yolking occurs in some ova as early as March, the most significant increase in both number of follicles involved and percent of weight gain occurs just before ovulation (usually July, see Fig. 7), so that there is no clear separation between the vitellogenic and ovulatory phases of the reproductive cycle.

Fig.7 depicts the progress of vitellogenesis in the Pakistani population examined. Because the

TABLE 2

SEASONAL VARIATION IN SIZE (MM) AND WEIGHT (G) OF TESTES IN *Varanus flavescens* (DOKRI, PAKISTAN POPULATION)

| | | Diameter | | Length | | Weight | |
|---|---|---|---|---|---|---|---|
| | N | X | OR | X | OR | X | OR |
| Jan. | 3 | 7.9 | 5.1-9.8 | 17.1 | 15.5-20.4 | 0.3 | 0.3-0.4 |
| Feb. | 1 | 6.8 | | 15.1 | | 0.4 | |
| Mar. | 6 | 7.9 | 4.4-11.8 | 16.3 | 11.1-21.7 | 0.4 | 0.3-0.6 |
| Apr. | 4 | 7.6 | 5.5-9.8 | 18.7 | 15.1-21.5 | 0.3 | 0.2-0.4 |
| May | 5 | 14.0 | 13.0-15.9 | 25.7 | 19.1-37.1 | 2.4 | 1.9-3.0 |
| Jun. | 3 | 12.7 | 12.0-13.0 | 22.6 | 18.9-25.5 | 1.7 | 1.0-2.1 |
| Jul. | 3 | 14.7 | 14.4-15.1 | 25.0 | 23.7-25.9 | 2.7 | 2.5-3.0 |
| Aug. | 4 | 11.6 | 8.2-13.6 | 21.4 | 18.7-24.1 | 1.3 | 0.5-2.0 |
| Sep. | 13 | 5.5 | 4.2-8.2 | 12.9 | 9.3-17.7 | 0.4 | 0.2-0.6 |
| Oct. | 4 | 6.8 | 5.6-8.6 | 14.2 | 12.0-18.0 | 0.2 | 0.2-0.3 |
| Nov. | 12 | 7.2 | 6.0-8.4 | 17.8 | 16.0-18.4 | 0.3 | 0.1-0.5 |
| Dec. | 3 | 8.7 | 7.1-9.7 | 14.3 | 11.5-15.8 | 0.3 | 0.3-0.3 |
| N | 61 | X 9.3 | | X 18.4 | | X 0.9 | |

climate is so similar throughout the rather limited distribution of this species, we believe that this summary reflects the reproductive cycle throughout the entire range of this species.

All eggs oviposited by freshly caught individuals (3 clutches) were laid during the course of a single day. Visser (1985) reports that in captivity his female laid eggs at a rate of about one per hour, but believes that the entire oviposition behaviour of this female may have been abnormal. We agree, for the rate at which our specimens laid their eggs was much higher. Considered on an annual basis, egg laying in *V. flavescens* occurs during a relatively short period * three months maximum. An analysis of the weight of abdominal fat bodies in this species also reflects a single annual cycle. This is important in the context of possible use of abdominal fat reserves during the vitellogenic process.

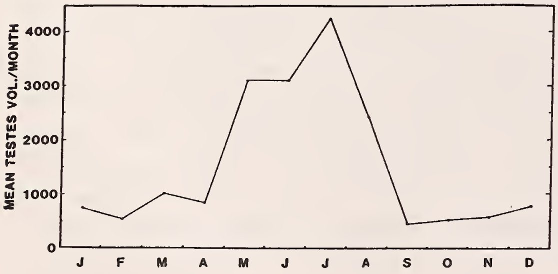

Fig. 8. Annual pattern of mean testes volume in adult *V. flavescens* from Dokri, Pakistan.

Very few data are available on the size of the annual reproductive female cohort in varanid lizards. For *Varanus olivaceus* (Auffenberg 1987) it is estimated that 90 percent of all mature females lay eggs each year. For the Pakistan adult females of *V. flavescens* we estimate this statistic as about 52 percent (though 100% of the small August sample were gravid).

### MALE REPRODUCTIVE CYCLE

Few data are available regarding seasonal testicular changes in varanid lizards. Testes enlargement during the breeding season has been reported for *Varanus bengalensis* (Upadhyay and Gukaya 1972), *V. griseus* (Kehl and Combescot 1955) and *V. olivaceus* (Auffenberg 1987). The same pattern is now demonstrable for *V. flavescens*.

Average testicular volume is lowest from September through February (Fig. 8, Table 2). It increases from March to the annual peak in June and July. In August the weight drops rapidly to

Table 3

EGG MORPHOMETRICS OF *Varanus Flavescens* (ALL LOCALITIES COMBINED)

| Clutch No | Diameter (mm) X | Diameter (mm) OR | Length (mm) X | Length (mm) OR | Weight (g) X | Weight (g) OR | No of Eggs |
|---|---|---|---|---|---|---|---|
| 1 | 19.0 | 18.1-21.3 | 39.5 | 34.8-43.2 | 10.7 | 0.2-11.6 | 18 |
| 2 | 22.0 | 20.5-22.5 | 36.0 | 34.4-37.0 | 11.1 | 0.4-11.9 | 14 |
| 3 | 21.8 | 20.5-22.5 | 37.1 | 36.4-37.8 | 10.4 | 0.0-11.4 | 6 |
| 4 | 21.2 | 20.3-23.0 | 37.3 | 35.2-38.1 | 10.8 | 0.2-11.8 | 6 |
| 5 | 21.5 | 20.5-22.5 | 35.7 | 34.4-37.0 | 10.5 | 0.1-11.5 | 4 |
| X | 21.0 | | 37.1 | | 10.7 | | |
| SD | 1.2 | | 1.5 | | 0.3 | | |

the lowest level of the entire year. Mean testicular weight data show the same seasonal pattern, so that testes mass and volume are largest during June and July — the presumed courtship period. This is the time of year when Visser (1985) noted courtship and breeding in his captives in Europe as well. Testes colour also changes seasonally. The usually greyish white testes become distinctly yellowish during the height of the reproductive period.

### Sex Ratio

Seasonal proportional representation of males and females captured/examined was also analyzed. This shows that the overall annual sex ratio is slightly in favour of males (57%). This is due to the fact that males are significantly more common than females from May through July ($\bar{X}$ 76.7% of the total monthly samples for these three months). During the remaining nine months the sex ratio is 1:1 (mean male proportion 51%). This increase in number of males taken during the courtship period and that immediately preceding it has been demonstrated in several species of skinks (Auffenberg and Auffenberg 1987) and is particularly noted in *Varanus bengalnesis* (W.A. notes). As in *V. bengalensis*, the mature females of *V. flavescens* are predominant during the height of the breeding period (July males of *V. flavescens*, 43%).

### Egg Morphometrics, Complement and Hatching

The eggs of all varanid species have a soft, relatively smooth, leathery shell, without surface ornamental or crystalline material. While the eggs of some species adhere to one another in one or more masses, those of *V. flavescens* are always separate.

Eighty eggs of *Varanus flavescens* were measured and weighed (Table 3). Mean and overall range in length, diameter and weight are 37.1 mm (34.4–43.2), 21 mm (18.1–23.0) and 10.7 g (10.0–11.8). The average total mass of the entire complement is 282.6 g, or 42.2 % of the average mature female total weight $\bar{X}$ = 768.5g, N 86).

Based on the number of eggs laid in captivity and the evidence from the oviductal chambers of females that had already oviposited, the number of eggs per clutch varies from four to thirty ($\bar{X}$ = 16.0, SD 10.2). This agrees fairly well with the number of developed ovarian eggs ovulated annually, as evidenced by the number of corpora lutea counted in the ovaries ($\bar{X}$ = 11.7, SD 6.45). Though sample size is small, clutch size is probably positively related to female size, as has been demonstrated for *V. olivaceus* (Auffenberg 1987).

No data are available on nest construction or site selection in *Varanus flavescens*. Visser (1985) has shown that incubation time in this species is 149–155 days at an incubation temperature of 30°C. The direct correlation between annual rainfall pattern (i.e. the arrival of annual monsoon rains) and the reproductive pattern of the species (and *V. griseus* and *V. bengalensis* in the same geographic range, W.A. notes) suggests that this is the single most important factor in reproductive cycling of *V. flavescens*. If the incubation time reported in captive animals by Visser also holds under field conditions (which is likely, given a mean soil temperature of 28.3° C during the developmental period; data from this study), young would be injected into the local ecosystem from December through February. This is a cool period throughout the northern parts of this species range, when adults are definitely more or less inactive. Thus it is highly unlikely that neonates of this species would be very active either. In India, hatchlings were found in the field from March to July, suggesting that while development may be completed in five months, emergence from the nest may be delayed by a further one to four months. The March sightings (West Bengal) come from the more eastern parts of the species range, where monsoon rains come early, and the July dates (Uttar Pradesh) from areas where the monsoon arrives much later. Delayed emergence (in the field), has been shown to be dependant on local rainfall in other monitor species (see Auffenberg 1987, for review).

## GEOGRAPHIC DISTRIBUTION

Because of the poor representation of this species in museum collections, the several important mis-identifications with *Varanus bengalensis* in the past, and the new information gathered during this study, we list all those localities from which definitely identified *V. flavescens* are now known. The list is based on specimens examined in museums, collected or observed in the field during the course of this study, figured in the literature, or otherwise described in terms that leave no doubt as to the correct identification.

**Bangladesh:** Dinajpur District, Parbatipur (d' Abreu 1932); Madhupur, Mymensingh Dist. and Salna village, Dacca Dist. (Whitaker & Hitada 1981). Faridpur District, Madaripur (this study); Dhaka District, Narayanganj this study).

**India:** *Assam:* Gauhati Dist., Gauhati (Indian Museum); Dhuburi Dist., Goalpara (=Golpara) (Smith 1932).

*West Bengal:* Terai Dist., Shiliguri (=Silliguri, Chicago Museum Natural History); Calcutta Dist., Calcutta (Indian Museum and Vienna Natural History Museum), Calcutta Botanical Gardens (Indian Museum); Sagar Island, Pathar Pratina (Indian Museum); Krishnagar Distr., Krishnagar (Indian Museum); 24 Parganas Dist., Pepouldo and Melanchar Thana (Chicago Natural History Museum); Kakdwip (this study); Hoogley Dist., Singui Thana (Chicago Natural History Museum); Medinipur Dist., 20 km NW Kharagpur (Sights 1949), Medinipur (= Midnapur, Smith 1932);

*Orissa:* Balsor Dist., Serogatrth, 8 km E Nilgiri (indian Museum, Biswas & Kar 1982, and this study); Cuttack Dist., Nandan Kanan (Indian Museum), Bhitarkanika, Dangmal (Biswas & Kar 1982); Barang Dist.,NE Nandan Kanan Biological Park (Biswas & Kar 1982)

*Bihar:* Patna Dist., Patna (d'Abreau 1932 and this sudy); Saran Dist. (Smith 19332), 4 km SW Chhapra (this study); District ?, Gordon Hill (locality not found) (Mertens 1959 b); Bettiah Dist., 20 km NW Bettiah (this study); Pargani Dist., Pakaur (= Pakur, Smoith 1932).

*Uttar Pradesh:* Gorakpur Dist., Gorakpur (Indian Museum); Fatehgarh Dist., 10 km SE Fatehgarh (this study); Varanasi Dist., 21 km SE. Varanasi (this study); Mirzapur Dist., 10 km W. Mirzapur (this study); Agra Dist., Agra (Anderson, 1871, Indian Museum); 5 km N. Dayal Bagh (this study); Gaziabad Dist., 23 km S. New Delhi (sight record only, this study).

*Haryana:* Amballa Dist., Amballa (Smith 1932, reporting on specimen in Indian Museum, confirmed during this study, see below).

**Nepal:** 'Nepal', no further data, reported first by Canton 1849 and later by Boulenger 1885 (based on specimens [confirmed during this study] in the British Museum); Chitwan (Gurung 1983, US National Museum); Arun River vvalley, Sagarnatha National Park (R. Jackson, *in litt.*).

**Pakistan:** *Sind Prov:* "Sind" (Murray 1884); Larkana Distr., Dokri (Mertens 1942, reporting on specimens in Senckenberg Museum, confirmed in this study, Florida State Museum, and Zoological Survey Pakistan); Dadu Dist., Dadu (this study).

*Northwest Frontier Prov.:* Peshwar Dist., Sholgara Village, near Charsadda (Zoological Survey Pakistan). 'Dir and Swwat', no definite localities (McMahon 1901).

*Punjab Prov.:* (Jhelum Dist., near Dina (Zoological Survey Pakistan); Sargodha Dist., near Laya (collections previously made by professional hunters, but not confirmed during this study); and Lahore Dist. (?), near Pindi Bhatian (same comment as previous record).

All of the definite localities listed above are along, or near major rivers, of which the Brahmaputra, Ganges, and Indus are the major ones. In Orissa, India, they are also known from the drainage systems of the Brahmani and Mahanadi rivers. In these stream valleys *V. flavescens* extends along major tributaries to the foot of mountainous regions–even the base of the Mt. Everest complex–but not into the highlands above the tropical zone. Thus the distributional pattern is almost identical to that of *Gavialis gangeticus* and other typical Indo-Gangetic Plain species (including the Orissa river systems mentioned).

On the basis of geography and local environment, we expect that *V. flavescens* will eventually be found in Arunachal Pradesh in India, along the Dihang and Lohit river valleys. In Nepal the species probably occurs mainly along the southern border and posssibly restricted to the floodplains of the Arun river in the southeast and the Girwa river in the southwest, both or which are tributaries of the Ganges, along which the species is locally common.

The following localities are definitely in error, most based on mis-identifications of *V. bengalensis* (or *V. dumerilii* in a few cases) as *V. flavescens*, or records from illogical environments or geography on the basis of what is now known about the species (see below for habitat details).

''Penang'', first reported by Cantor (1847), and followed by Gunther (1864), Murray (1884), Flower (1896, 1899) and Boulenger (1912). All Malaysian records (listed here) were denied by Smedley (1932), with which we agree.

''Malay Peninsula'', a generalized distributional statement, perhaps based on Cantor's ''Penang'' record (1847), first listed as Malay Peninsula by Boulenger (1885) and followed by Boulenger (1890), Flower (1896, 1899), Boulenger (1912) and Flower (1929); see comments above regarding ''Penang''.

''Trang'', Thailand, mentioned only by Boulenger (1912). *V. flavescens* does not occur in this area on basis of field work by Auffenberg (field notes, 1974).

''Concan and Deccan'', in south and central India, reported by Murray (1884), on no valid basis as far as we can determine. The species does not occur there. (Auffenberg field work, 1979, 1984- 5).

''Baluchistan'', Pakistan, Murray (1884), undoubtedly based on misidentification with *V. bengalensis for V. flavescens* does not occur there on the basis of absence of appropriate habitat.

''Indochina'', first reported by Tirant (1885), followed by Mocquard (1906), undoubtedly based on misidentification with *V. bengalensis*. No voucher specimens available anywhere.

''Pegu and Mergui'', Burma, mentioned as a *possibility* on basis of material in hand by Theobald (in Mason, 1882), and followed by Murray (1884), Boulenger (1885, 1890, 1912), Flower (1896, 1899, 1929), and Annandale (1905). No voucher specimens available from Burma.

''Ceylon'', listed by Murray (1884), is undoubtedly based on misidentification with *V. bengalensis*.

''Nurpore (= Nurpur), Salt Range'', Punjab, Pakistan, first reported by Hora and Chopra (1923) and followed by Smith (1932). This record is certainly based on a *V. bengalensis*, as most of the environment is probably inappropriate for *V. flavescens* though *V. bengalensis* is locally common.

''Padang, Sumatra'' mentioned by Holtzinger —Tenever is clearly incorrect, but interesting because of the importance of this locality in the distributional pattern of *V. bengalensis*

''Kutch'', Gujarat Prov., India, (Murray 1884) is possibly correct. Throughout its long history, the Indus river has been notably vagrant, exhibiting extraordinary wanderings and mutations of its course in response to natural and man-induced environmental changes. The major change in the delta region is the westward drift of the major distributaries. Not too many thousands of years ago these emptied into what is now the Rann of Kutch (see Holmes 1968, Flam 1986) — a broad, level expanse of largely saline mudflats that tend to become flooded each year due to monsoon winds. While *V. flavescens* is not known to occur in brackish water situations (see below), it has been collected very close to the sea at Sagar Island, West Bengal. Since some of the flooding in the Rann is due to freshwater inundation from Sind, Pakistan, and because appropriate habitats for this species might occur along these seasonal distributaries in the interior of the nearby country, Murray's old record of this species from Kutch may be correct. However, *V. bengalensis* (with which Murray clearly confused *V. flavescens* in other instances) is common in the Rann of Katcch area (W.A. field notes). Appropriate habitats for *V. flavescens* occur in marshlands north of Bhavnagar, Gujrat, and along the lower reaches of the Sabarmati river north of Ahmadabad, Gujarat (W.A. field notes), which are both also part of the ancient Indus river delta (Karpov and Nebolsine 1964). These may also be found to possess *V. flavescens.*

Fig.9 shows all of the definite localities from which *Varanus flavescens* is now known, as well as the expected range. This distribution shows quite clearly that the species is restricted to the rivers of the Indo-gangetic Plain. Thus the species is found in the Indus, Ganges and Brahmaputra rivers and all of their tributaries, except those of the Ganges that are considered "peninsular" (Chambal, Betwa and Ken Rivers, see Mani 1974). Except for the lower deltaic parts of the Ganges—Brahmaputra system, this monitor species seems restricted to the *Khadar* alluvium in the floodplains themselves. Where broad these floodplains are characterized by dead arms, deferred junctions and marshy *jheels*, often several kilometres wide. Near the foothills of the Himalaya, *V. flavescens* seems restricted to the more level areas of finer soil, often covered with marsh and swamp vegetation of the terai, rather than the areas of coarser talus (*bhabar* and *bhur*).

In West Bengal and Bangladesh *V. flavescens* is apparently more widely distributed than in the rest of the Gangetic Plain, where it seems to occur in isolated populations. In Pakistan the distribution is apparently even more spotty, though further collecting may disclose additional localities along major streams in appropriate habitats.

## HABITAT

Early in the accumulation of information regarding this species, the notion was developed that *V. flavescens* lived in dry grasslands. This conclusion was undoubtedly fostered by two misconceptions. First, that *V. flavescens* was closely related to *V. exanthematicus*, the African savanna monitor, which does live in xeric habitats. Second, that not all specimens collected and identified as *V. flavescens* were, indeed that species. Some of these were clearly *V. bengalensis*, which is often found in dry habitats (though not optimum). Mertens (1942) had no reason to doubt what had been stated about the habitat of *V. flavescens*, but was puzzled by its flattened tail — usually associated with aquatic species (i.e. *V. salvator*). He concluded that the flattened tail in the former was a retention of that condition, rather than a specialization for the habitat in which it was presumed to live. Rotter (1963) continued the error in an important and the most recent synopsis of the genus, in spite of the fact that Sights (1949) published a good description of the generally wet habitat of *V. flavescens* in West Bengal. In that paper, Sights emphasised the mesic to hydric environment in which he found his specimens—a heavily forested tract with many marshes and brooks.

In 1979 Auffenberg studied the habitat of this species in many places in the Gangetic Plain and during 1986-7 he and the junior authors studied it in several parts of the Indus river. These observations, plus notes available in the Chicago Natural History and Indian Museums (associated with

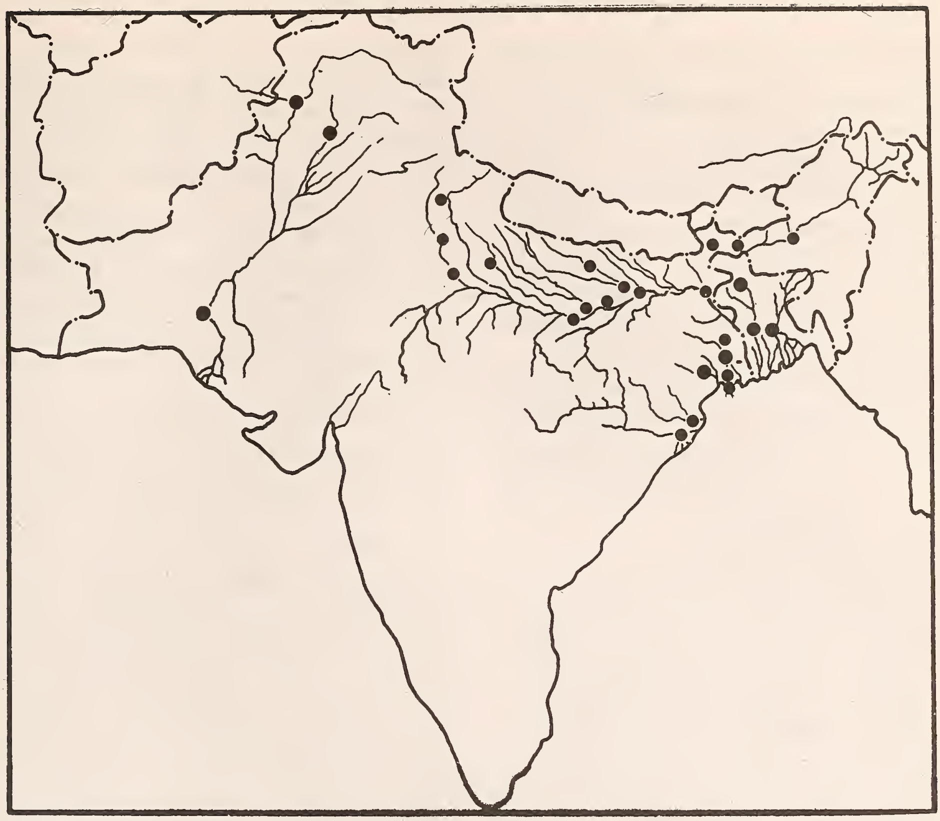

Fig. 9. Confirmed locality records (dots) for *V. flavescens,* with all major rivers of the Indo-Gangetic plain shown.

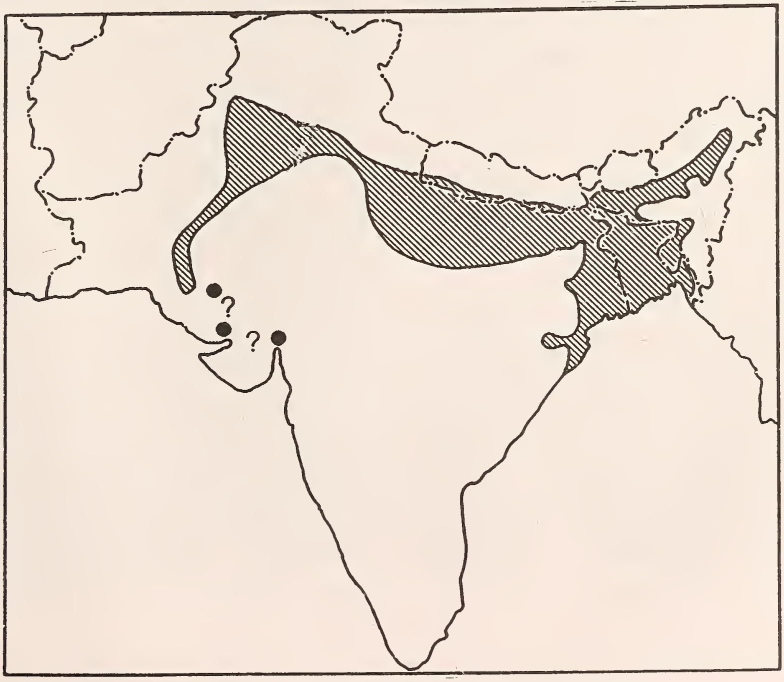

Fig. 10. Probable distribution limits of *V. flavescens* (shaded), with possible extensions in Sind-Gujarat provinces shown.

specimens collected in Orissa and West Bengal), made it clear that *V. flavescens* is primarily a species of marshlands (jheels) in low-lying, sandy areas bordering large rivers and subject to annual flooding. This hydric habitat occurs in almost every locality where the species was observed in the wild. The only exception is along canals associated with rice farming in low- lying areas. For the most part, these rice growing areas were previously partly or completely located within the boundaries of former natural marshlands.

In the meantime, Visser (1985) noted that healthy captives kept under optimum conditions in Europe spent much time in water. Combining these observations with those of Sights (1949), he correctly concluded that the species lived in moist to wet, rather than dry habitats.

The following is a brief list of the major plants found in optimum habitat of *V. flavescens* in northern India; trees include mainly *Dalbergia sissoo, Albizzia procera, Acacia arabica* and *A. catechu*; dominant shrubs are *Tamarix dioca, Zizyphus jujuba, Ehretia laevis* and *Holoptelea integrifolia* grasses. Herbs include *Saccharum spontaneum, S. munja, Phragmites communis* and *Typha elephantina* (or *T. angustata*). In Assam, *Pistia aquatica* and *aldrovanda vesciculosa* are common aquatic plants. Closer to the coast in Bangladesh, West Bengal and Orissa, the tree *Heritiera minor* becomes very common. In Pakistan typical trees in the local habitat include *Populus euphratica* and/or *Acacia nilotica*; dominant shrubs are *Tamarix dioica* and *Zizyphus jujuba*; dominant grasses and herbs are *Phragmites karka, P. communis, Typha augustata* and *Nelumbium* sp. *Varanus flavescens* is not found close to the coast in Pakistan.

In addition, this monitor lizard is often found in and near irrigated fields in both India and Pakistan. Most of the time these are paddy fields, as on Sagar Island, West Bengal, but they may also be maize or mixed crops, as at Charsadda, near Peshawar, Pakistan. In fact, much of the original flood plain habitat throughout the range of this species has been greatly modified by agriculture. In some instances, entire local populations of this lizard have been extirpated in this way. The situation along the Yamuna river near Agra is a good example. The species was first reported from the area by Anderson in 1871. However, no specimens have been found there recently, in spite of the fact that the Agra area is an important source for preserved biological materials used by universities and colleges over much of northern India. Some specimens from the same locality had been deposited in the Indian Museum some time ago (we have confirmed these identifications).

In 1979, 1984, and 1985 the senior author had opportunity to study monitor populations in the Agra area — partly to determine the habitat from which the *V. flavescens* might have originated. Discussions with aged professional animal collectors in the area made it clear that the species was once found near Agra, but only in previously annually inundated lowlands dominated by *Typha*. It is still found (though rare) in similar habitat north of Agra along the Yamuna river, as well as eastward along the main floodplain and tributaries of the Ganges river (common locally). At Dayal bagh, a suburb of Agra, very small, scattered *Typha*—filled lowland areas can still be found. these are small remnants of much larger jheels originally found in the area. Since acquisition of the land by the Rhadasomi community many years ago, most of these jheels have been converted into irrigated paddy fields and the small local populations of *V. flavescens* once present have long ago disappeared.

The same pattern of marshland conversion to paddy has occurred on a massive scale throughout much of the Indo-Gangetic Plain in the past and is responsible for much reduction in range and abundance of this species. This factor, plus the natural long term trend of desertification of at least the western half of the range of this species, and the restriction of marshy areas to flood plains to begin with, accounts for the very spotty distribution of the species at the present time. This distributional pattern is additionally impacted in some areas by a high hunting pressure for its skin. Collectively, these factors lead us to consider

*Varanus flavescens* as the most endangered of all monitor species on the Asian mainland. What habitat remains is small, and is becoming smaller all the time — particularly in the central to western parts of its range.

In India (West Bengal and Assam only) and Bangladesh, *Varanus flavescens* is sometimes sympatric with both *V. salvator* and *V. bengalensis* (sometimes all three species can be seen in the same marsh). In Pakistan (all provinces in which it occurs) it can be expected to be found in the same habitat with *V. bengalensis*; *V. griseus* is only found in xeric, sandy habitats; it is never syntopic with *V. flavescens* ecologically.

## FOOD

Captive *Varanus flavescens* regularly feed upon mice (Auffenberg captives in Florida and Visser 1985) and prepared reptile food (Visser 1985). During this study, evidence of prey was found in 32 individuals (all adult, stomach-pumped in the field or dissected in the laboratory). These remains included frogs, toads, amphibian eggs, reptile eggs (turtles and squamates), birds and their eggs, insects and mammals (all rodents). Because of their advanced state of digestion, species identification were usually not possible.

Forty percent of all prey were frogs (all *Rana* sp.) Toads (all *Bufo stomaticus*) comprised nine percent of the prey. Reptile eggs (turtle and squamate eggs combined) totalled fifteen percent; six percent was mammalian and the same for insects. A few individuals had masses of frogs eggs in the stomach. These were fertilized so that it is clear the eggs had been found in the wild and not the remains of a female frog eaten previously. Feathers were found in only three percent of those that contained prey; bird eggs the same. Thus frogs comprise the most common prey, followed by reptile eggs. Because no scales or other reptile remains were found in the stomachs at the same time we surmise that the eggs were taken from the nests. Many species of monitors are known to feed extensively on reptile eggs so that this is not unexpected in *V. flavescens*.

However, what does seem unusual in the diet reported here is the eating of amphibian eggs. This has not been reported for any other varanid lizard so far. What is also somewhat surprising is that no land or water molluscs are apparently included in the diet, though at least the aquatic viviparid. *Bellamya bengalensis* (*sensu latu*) is common in local shallow marshlands where they could easily be foraged by the monitors. Some other monitor species regularly feed on molluscs (see Auffenberg 1987 for review). Of possible significance is that most of the amphibians found in the gut were taken from individuals collected in September-October; most reptile eggs in February; mammals only in March-April.

## GROWTH

No direct information is available on growth of wild individuals. However, *in vitro* staining of bone laminae in wild individuals and data from captivity (Visser 1985) suggest that sexual maturity occurs at about three years. Since mean hatchling SVL is approximately 77 mm and sexual maturity is attained at about 290 mm SVL, the annual estimated SVL growth (if uniform, which it is not) is about 60 mm/year. Because food resources and activity level of the monitors is not uniform throughout the year in view of the seasonal climate of the regions inhabited by the species, growth must be pulsed. The periodicity of this growth pulse can be demonstrated by percent individuals shedding each month.

No individuals were noted shedding their skins from October through December (specimens examined 31). From January through April, seven to twenty percent of all individuals examined (36) were shedding their skins. Shedding becomes much more common from May through September (37), when they represent 37 to 60 percent of the monthly totals examined. Thus we conclude that the least growth is experienced in the fall post-monsoon season, and the highest growth rate during the monsoon season.

Shedding is an indication of growth and as such must occur during and (particularly) after the period of greatest food abundance. If this is the case, then the least food is obtained during the summer monsoon, for the following period is the one of least evidence of growth. That this is quite probably the case is suggested by the seasonal pattern of fat accumulation (Fig. 4), which shows that the monsoon season is a period of high utilization (degradation) of existing fat in the abdominal cavity in both sexes, rather than a period of accumulation. The lack of growth is perhaps best explained by the low density of food in the habitat, caused by annual monsoonal flooding. this is also reflected in the fact that very few food items were found in the gut during this period. On the other hand, both food contained in the stomach and fat in the abdominal cavity were high during the dry premonsoon period, when most food sources (particularly the most common prey, frogs) would be concentrated in the few small pools of surface water remaining in the habitat. This period of rapid growth is reflected in the high shedding levels noted during the following monsoon period, due to the time lag between food abundance and actual growth and eventual shedding. The entire matter of seasonal growth (amount and lag time) in relation to seasonal variation in food availability deserves attention and would probably handsomely repay investigation in both the laboratory and field.

### OTHER REMARKS

As part of a study of the external parasites of all the varanid lizard species of Pakistan, we were surprised to find that while *Varanus bengalensis* adults were regularly and heavily infested with ticks (*Aponoma gervaisi*), no recently caught specimens of *V. flavescens* from India (Varanasi, Fatehbad, Mirzapur) or Pakistan (Dokri, Charsadda, Dina) ever had any ticks, nor possessed any evidence (tick scars) that they had ever been there. This is particularly unusual in view of the fact that in both countries both monitor species can often be found in the same habitat (though local animal catchers and hide hunters claim that they are never found in the same burrows). The only time that ticks were ever found on *V. flavescens* was when the lizards had been kept in the same bag or pen in which *V. bengalensis* had recently been kept. At such times when ticks were found on *V. flavescens* we noted that tick distribution on the host was not typical of the pattern regularly found on *V. bengalensis* (W.A. field notes, see Auffenberg 1987 for data on tick site attachment on other varanid species hosts).

No studies have yet been completed on the internal parasites of this species, though appropriate material has been collected and is now in the hands of specialists in such matters. Nematode parasites are being investigated by workers in Pakistan. Dr S. Telford, Florida State Museum, is currently studying blood parasites of *V. flavescens* caught near Dokri, Pakistan. This material proves that this monitor is often infested with a blood parasite (probably malarial) that is not found in either *Varanus griseus* nor *V. bengalensis* in any part of their geographic ranges (Dr Telford will report his results separately when his studies are completed).

Thus what little is known about the parasites of *Varanus flavescens* suggests a very different picture from that reported or known to exist in other Indo-Pakistan monitors. These data further substantiate the presumably isolated phylogenetic position of *V. flavescens* based on studies of blood chemistry, penial morphology and karyotypes as indicated above.

Compared to other varanids in which injuries were studied (Auffenberg 1981, 1987), *Varanus flavescens* shows remarkably few scars, even when compared with *V. bengalensis* from the same habitat in Pakistan. There is no consistently scarred area(s) caused during combat, feeding, or in shelters, as in the other species studied. Though snipped-off tail tips are common in other species, this occurred only once (a male) in 87 *V. flavescens* examined for this character in Pakistan. Of 38 *V. bengalensis* from the same habitat in Pakistan, 26% (7 males, 2 females) had the tail snipped off. Tail injuries in *V. komodoensis* are usually due to courtship by the males (Auffenberg 1981). This may also be the case in *V. bengalensis*, since more females than males have the tail tip snipped off. The absence of such injuries on the tail of *V. flavescens* suggests that the courtship pattern in this species does not involve much biting by the males, or at least not on the tail.

A necrotic liver was noted in one adult from India; an ovarian tumour in another individual from Pakistan.

The pH of the empty stomach was tested in three individuals; it ranged from 2.2–2.9, X = 2.5

d'Abreu (1932) states that during the dry season this species takes refuge in large cracks in the earth. While this may be an accurate description, the species also digs burrows in which it spends the night and the cooler weather of the winter months. It may also use such burrows for aestivation during particularly dry periods. Pakistani tribals very experienced with this animal claim that, unlike *V. bengalensis* and *V. griseus*, it often closes the mouth of its burrow at night. We were not, unfortunatley, able to verify this. If true, it seems to be the only species of monitor lizard that does so.

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# INTRUSION OF A RHESUS *MACACA MULATTA* PAIR INTO A LANGUR *PRESBYTIS ENTELLUS* GROUP[1]

REENA MATHUR AND A. LOBO[2]

In the course of 3400 hours of field observation on free ranging langur *Presbytis entellus* in Jaipur, India, during 1985 and 1986, six cases of rhesus *Macaca mulatta* associating (as residents) with langur groups were observed in the thirty censused groups. One of these associations involved an adult rhesus pair and a unimale bisexual langur group which was extensively studied at the Ambagarh reserve forest. This report presents data on their interaction during the initial seven months of the rhesus residency in the langur group. Most of the interactions involved langur adult females with infants and the male rhesus. The female rhesus seldom interacted with the langur individuals. A possible fitness enhancing strategy is suspected behind the social isolation of the rhesus from its conspecifics.

*(With two text-figures)*

## INTRODUCTION

Polyspecific association in non-human primates has been reported from a number of study sites (Bernstein 1967, Gartlan & Struhsaker 1972, Freeland 1977, Rudran 1978, Das and Sharma 1979, Waser 1980). Most of these associations are temporary and occur due to overlapping activity ranges. However, a few cases of long term intertaxa association have also been reported (Bernstein 1967, Dolhinow 1972, Das and Sharma 1980, Mohnot 1984).

This study examines the interaction between rhesus and various age and sex classes of the Hanuman langur *Presbytis entellus* after the forceful intrusion of the former into a unimale bisexual langur group designated as G–3. This type of association between rhesus and langur has been observed in as many as six groups (four unimale, one multimale and one all male band) out of the thirty censused langur groups in Jaipur. Each of the groups excluding G–3, had an adult rhesus male resident. The pair with G–3 gave birth to an infant later. Association of one or more langurs with rhesus groups was not encountered.

## STUDY AREA AND METHODS

The study area was the Ambagarh reserve forest situated on the eastern border of the city of Jaipur, Rajasthan, India. The vegetation is of dry deciduous type dominated by *Anogeissus pendula, Maytenus emarginata, Holoptelea integrifolia* and a number of *Acacia* species. Rainfall averages 600 mm per annum and is strongly seasonal, with almost all rain falling during the month of July and August. Winter (November to February) temperatures vary between 6°–15°C, while the summer (April to June) temperatures may reach as high as 47°C.

Seven groups (five bisexual, two all male) of langurs inhabit this area . Extensive observations were made on a unimale bisexual group (G–3), which had a resident rhesus pair.

Data on interactions between the rhesus pair and the langur group G–3 was collected systematically during the ten days of each month while scan sampling G–3 for its activity pattern and feeding ecology. Sampling all occurrences of some behaviour was the method of choice (Altman 1974) for recording interaction between rhesus pair and langurs.

## RESULTS

**Rhesus–langur infant interaction:** The rhesus

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pair was never observed in direct aggression or any other form of interactive action towards langur infants. The infants who wandered away from their mothers in the course of exploration hurried back to them when the rhesus got near while passing by or while relocating himself or herself within the group.

**Rhesus–langur juvenile interaction:** Small juvenile langurs who had just been weaned, avoided any form of interaction with the rhesus. They never indulged in instigations or challenged the dominant attitude of the intruders and readily moved away from preferred areas on approach of the rhesus. Avoidance in this case demonstrated a condition of fear, and submission of the small juveniles towards the aggressive rhesus.

All the langur juveniles in the study group were females. Rhesus–langur juvenile interaction constituted 19.5% of the total recorded interactions (Fig. 1), with a mean frequency of 6.3 encounters per day in December, followed by a significant fall (2.1, 2.3, 1.0, 2.1 and 2.8 encounters per day respectively; Fig. 2) in the following five months. A second peak of 4.1 encounters per day was recorded in June.

The behavioural repertoire of the large langur juveniles during an encounter was attention attracting: large juveniles would approach the rhesus within 5–10 m and start squealing. The duration of the squeal varied from as short as 2 sec to about 20 sec. The rhesus male generally ignored the squealers; however, if the squealing persisted he would threaten or even chase the stentorian. The female rhesus seemed less tolerant than the rhesus male and was always observed to threaten and even chase the large juveniles. The male and female rhesus threats involved: (1) the tense mouth face; (2) the startling open mouth face. Chasing, which seldom occurred, varied over dis-

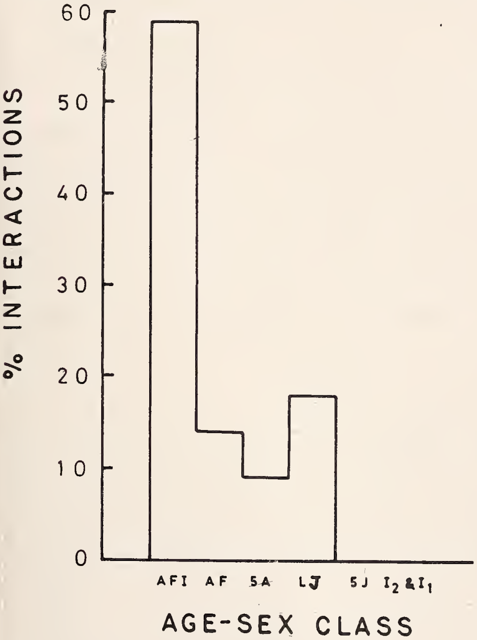

Fig. 1. Percent interaction of various age-sex classes of langurs with rhesus (December 1985 to June 1986). AFI: adult female with infant; AF: adult female; SA: subadult female (in this group there were no subadult males); LJ: large juvenile; SJ: small juvenile; I-2: infant 2(big infant) I-1: infant 1 (small black coat infant).

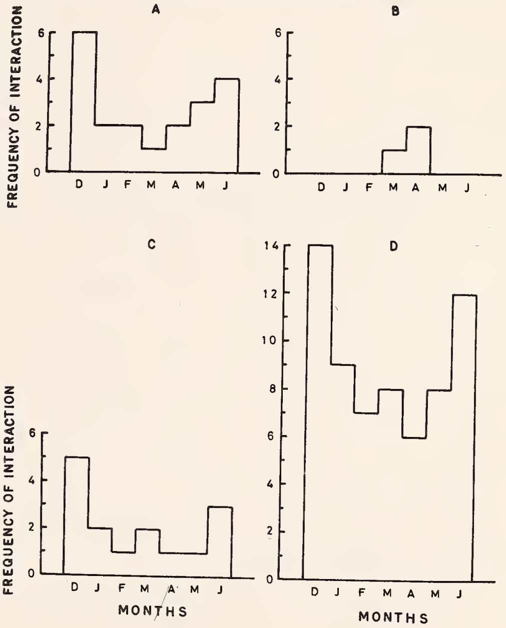

Fig. 2. Frequency of interactions (per day) between various age-sex classes of langurs and rhesus (December 1985 to June 1986). A: rhesus-langur large juvenile; B: rhesus-langur subadult female; C: rhesus-langur adult female; D: rhesus-langur adult female with infant.

tance of 5–50 m. Adult langur females would intervene during a chase in an attempt to defend the langur juveniles; intervention involved collective rushing by one or more individual at the rhesus. This usually terminated the chase.

**Rhesus–langur subadult interaction:** Subadult langur females were docile and unlike the juveniles, did not incite the rhesus. Interaction between the rhesus and langur sub–adults was rare, constituting only 2.6% of the total recorded data (Fig. 1). March and April were the only two months when interactions were seen to occur. Interactions are represented by 1.1 and 1.7 encounters per day respectively (Fig. 2). All interactions between the two occurred when subadult females tried soliciting extra–troop males or the new resident male during and immediately after male replacement (take over) in the unimale bisexual group G–3. Interaction involved threats and chase directed by the rhesus male towards the langur sub–adults. The chase in this case occurred over distances of 30 to 150 metres. Here too, adult langur females came to the rescue of the subadults in the same manner as described earlier. The female rhesus was never observed interacting with this class of langurs.

**Rhesus–langur adult female interaction:** The behavioural pattern of adult females (AF) and adult females with infants (AFI) towards the rhesus was quite distinctive. AFI avoided the presence of the rhesus pair. This was revealed by their circumspect, albeit wary, attitude. This class constituted the maximum number of the total recorded interactions between the rhesus and the langurs (61.7%; Fig. 1). December and July show a higher frequency of interaction. However, there is no significant difference between the frequency of encounters per day over the remaining seven consecutive months (Fig. 2).

The behaviour during an interaction between the rhesus male and AFI was characteristic and involved the following sequence: AFI moved towards the rhesus male, squealing, stopped a few metres in front of him, turned the infant upside down many times, nuzzled the infant, held its tail in her mouth, and then took off squealing and screaming. In some cases this act was performed without any vocalization.

This formed the most predominant behavioural activity of this class of langurs towards the rhesus male. However, it would be wrong to generalize this behaviour to all AFI. Factors such as the age of the adult female and the age of the infant seemed to play an important role in determining the probability of interaction. Adult females with new born infants never approached the rhesus male or rhesus female. The frequency of interaction between the rhesus and AFI also depended on the spatial distribution of the rhesus within the langur group. The rhesus occupied strategic locations such as a preferred resting site (the rhesus generally sat at the base of the tree or at the junction between the trunk and the first whorl of branches, thus preventing the langurs from moving into and out of the tree), preferred feeding site, a water hole, or remained seated in the path of group progression. Interaction between the rhesus and adult females without infants seldom occurred and did not involve the complex behavioural pattern mentioned above. All interactions which occurred did so over provisioned food or when the rhesus got in close proximity of the adult females. Interaction between the two involved threat gestures, chase and even a total indifference by the rhesus male towards the inciting AF. Many times the langur females emitted an *Ahhh* sound (produced by the forceful expulsion of air from the throat with the mouth remaining closed or partly open) directed towards the rhesus.

**Rhesus–langur adult male interaction:** Most interactions between the rhesus and langur adult males took place immediately after a take—over (change of adult male in a unimale bisexual langur group), with the rhesus male being the agressor in all recorded cases. Individual idiosyncrasies of the langur adult males played an important part in ascertaining the nature and intensity of the aggression directed towards them by the rhesus male. The degree of opposition faced by the aggressive langur male, from the rhesus male, was commensurable to the aggression directed by them towards G–3 individuals.

During and after a takeover the rhesus male threatened and chased the usurper male whenever he attacked or attempted to attack adult females with infants. One langur male ''MB'', who took over group G–3 twice, did not direct aggression towards AFI or infants. This male was readily accepted by the rhesus and G–3 individuals. Male ''XT'' was the most violent of the five males who had taken over G–3 from 24 December 1985 to 16 May 1986. Male ''XT'', unlike males ''CZ'', ''SE'', ''BF'' and ''Stumpy'' did not face any opposition from the rhesus male. Male ''CZ'' who came next in the hierarchy of ''New male–AFI aggression'' faced maximum aggression by the rhesus male. Over a period of seven days, 24 instances of rhesus male–''CZ'' interactions were recorded. All recorded cases were agonistic encounters and in relation to ''New male – AFI aggression''. On all 24 occassions ''CZ'' yielded to rhesus dominance with only three (12.2%) cases of retaliation.

Unlike the rhesus male, the rhesus female did not intervene during ''New male – AFI interactions'' and very seldom interacted with the langur male. All recorded interactions between the two took place over provisioned food, with the rhesus female being the agressor, but unable to displace the adult langur male. During such interactions the rhesus male was observed threatening and even chasing the adult male langur.

## Discussion

In the present investigation interaction between the rhesus and the langurs showed two peaks (December 1985 and June 1986; Fig. 2). The initial peak in December 1985 was due to the recent entry of the rhesus pair into the study group. The scarcity of trees with sufficient foliage to provide shelter from the high temperature (42°–47°C) during June, thus resulting in competition for shelter sites, accounted for the sudden rise in encounters during that month.

Polyspecific association in primates has usually been looked at from the point of functional advantage to one or both species. One of the most prominent of these advantages is antipredatory: an animal increases the probability of detecting a predator, and thus escapes (Gartland and Struhsaker 1972, Rudran 1978).

The potential predators at the Ambagarh reserve forest are hyaenas *Hyaena hyaena*, jackals *Canis aureus* and feral dogs *Canis familiaris*. Only one instance each of direct interaction with hyaenas and jackals was observed during the study period; but on a number of occasions potential predators were seen lurking within the activity range of the langur group. Langur interactions with known dogs were peaceful and the former were often observed picking out ticks from the latter, but with unknown dogs the interactions were always aggressive. A peaceful type of association between the dogs and the rhesus pair did not exist. Apparently association among these two species had no antipredatory advantage to the individuals of G–3, who live in a very large group of 117 individuals. The rhesus pair probably benefited from an increased probability of detecting predators in an area where hyaenas and jackals live.

During a takeover in G–3 the rhesus male chased langur females indulging in sexual solicitation of extra—troop males. It would probably be absurd to attribute this behaviour to dominance exhibition by the rhesus male, but this act most certainly had a detrimental effect on the acceptance of the rhesus pair by G–3 individuals.

The behaviour of adult females with infants towards the rhesus male was characteristic, and is accountable if looked at from the point of female anticipation of possible threat to the survival of offspring due to the presence of unknown intruders. ''Unknown'', in this case refers to the unfamiliar and unknown intentions of the strangers. This was substantiated by the non—exhibition of this behaviour by AFI one year after the intrusion.

The exhibition of aggression by the rhesus male towards adult langur males attacking AFI was perhaps an affectation, a strategy to inculcate acceptance by the female langurs who form the stable core of langur social organization.

Why the rhesus male left his group probably has reasons. Leaving is a functional response to increased population density; during splitting of groups in Japanese macaques animals who leave presumably gain advantages in terms of food availability, decreased breeding disturbance and reduced susceptibility to diseases (Furuya 1968, 1969, 1973). In some groups, individuals leave as a result of aggression directed at them by dominant male members of the group (Poirier 1969), to avoid inbreeding (Itani 1972), or to prevent depression of fitness (Hill 1974). In the present study the rhesus male left his natal group with a female. It is assumed that the fitness of the rhesus male must have been greatly reduced due to prevention of access to receptive females by dominant males. Hence, departure from conspecifics and taking along an adult female could possibly be a fitness enhancing strategy. Reproductive advantage due to isolation has been reported by Barash (1975) in Hoary Marmot which exhibits two distinct social systems: isolated family units and populous colonies. The male in the isolated family need not fear encroachment of competing males on his sexual prerogatives; social isolation is thus used as a fitness enhancing strategy. To say anything with certainty for rhesus regarding fitness enhancing strategy, long term empirical evidences for comparison are needed on the reproductive success of subordinate rhesus male living in his natal group. If social isolation could enhance the fitness of subordinate rhesus individuals, then why is it not that most, if not all, subordinate rhesus males leave their natal group? Only further investigation of the subject can answer this question.

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# ANTHECOLOGY AND EVOLUTIONARY CONSIDERATIONS OF *LEONOTIS NEPETAEFOLIA* R. BR.[1]

A.J. Solomon Raju and C. Subba Reddi[2]

*Leonotis nepetaefolia* R.Br. flowers with anthers dehiscing in bud stage produced inflorescence on the verticillaster every day. The flowers are capable of reproducing through autogamy, geitonogamy and xenogamy, but autogamy is the predominant mode and is successful even in the total absence of an extraneous agency. The animal visitors, avians – *Nectarinia zeylanica*, *N. asiatica*, a bee *Trigona* sp. are the regular pollinators. Butterflies, which are occasional visitors, seldom act as pollinators.

From the evolutionary point of view, the flowers of *L. nepetaefolia* with their scarlet colour, degenerated lower corolla lip, predominant autogamy, higher pollen–ovule ratio and greater amounts of nectar, are suggestive of the autogamous race now occurring in India as descended from a xenogamous race.

## INTRODUCTION

Cruden (1976) gave a brief account of the evolution of the weed *Leonotis nepetaefolia* R.Br., suggesting that the flower–form now occurring in India, Southeast Asia, Indonesia, Australia etc. has undoubtedly descended from a xenogamous – bird pollinated race. Except for this, the information on the flower biology and the pollination dynamics of *L. nepetaefolia* is not known. The purpose of the present study was to provide information on the anthecology and detail evolutionary considerations of *L. nepetaefolia* R.Br.

## MATERIAL AND METHODS

The herb *Leonotis nepetaefolia* R.Br. (*Phlomis nepetaefolia* L.) growing wild abundantly in waste places, open forests, banks of irrigation canals, and along roadsides at Turimella (15°10'N, 81°45'E), Prakasam District, Andhra Pradesh, India, was chosen for the study. The blooming phenological events at inflorescence and flower level were observed in detail. The inflorescence flowering life span was obtained after tagging ten randomly chosen inflorescences about to initiate bloom and followed every day until they ceased to flower. Concurrently, the flower morphological characters were also observed. Following the methods of Raju (1987), Horborne (1973), Baker and Baker (1973), pollen production per flower and pollen–ovule ratios, pollen viability, stigma receptivity, recording the flower life time, nectar monitoring and analysis and breeding systems were investigated.

Representative specimens of the butterfly visitors were caught, killed, preserved and identified with Wynter Blyth (1957) and Varshney (1983); the insect species by a comparison with the identified specimens (by CIE, London) and the avian species by visual examination from close quarters, and using binoculars, and identified with Salim Ali's books. The activity period of the foragers, type of forage, behaviour at flower, share in the pollination play etc. was also observed.

## RESULTS

**Vegetative and Flowering phenology:** Vegetative growth of *L. nepetaefolia* appears in September; flowering commences from mid—October and continues up to December/mid—January; thereafter the plants dry up.

The verticillaster inflorescence bears three verticils, each with an average of 162 flowers in the basal whorl, 188 in the second and 137 in the third

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whorl, producing over 63 days. The flowers are produced every day but each verticil does not flower successively.

**Flower morphology:** The floral parts show size difference in the first and the last formed flowers. The sessile flower is scarlet and gullet–shaped. Calyx tubular, ten–ribbed, green and hairy. Corolla is 2–lipped, tubular – the seat for the nectar produced at the base of ovary; upper lip is long, concave with a villous crown and lower lip small, 3–lobed and is poorly developed and non–functional. Stamens are 4, epipetalous, didynamous, housed inside the upper corolla lip, filaments hairy and hold the stamens together. Gynoecium is bicarpellary, tetralocular, syncarpous superior ovary with gynobasic style; stigma bifid—unequal lobes and situated below the stamen position.

**Floral dynamics:** Flower opening is accomplished every day over a short period during 2200 to 0200 hrs. The same schedule was evident on different weather days. Anthers open 20–30 minutes ahead of anthesis. Pollen gradually drops off from the anther onto the stigma geotropically in small clumps. Pollen output per flower came to be 10412 (X); they are spheroidal, 44 mm, surface smooth and cytoplasm granular, and are viable for 44 hours of anther dehiscence. Pollen–ovule ratio is 2603:1. Stigmas are receptive after anthesis and remain so for 37 hours, then corolla with stamens and stigma drops off. Calyx persists and shelters the developing seeds in it. Nectar production began two hours before anthesis and ended at

TABLE 1

FLOWER VISITORS ON *Leonotis nepetaefolia;* FORAGE TYPE AND BODY PARTS OF POLLEN DEPOSIT

| Flower visitors species | Forage type | Pollen deposit region |
|---|---|---|
| Hymenoptera | | |
| *Apidae* | | |
| *Trigona* sp. | Pollen | Ventral side, legs, head |
| Formicidae | | |
| *Camponotus sericeus* | Nectar | -do- |
| Lepidoptera | | |
| Danaidae | | |
| *Danaus chrysippus* | -do- | Proboscis |
| *Euploea core* | -do- | -do- |
| Pieridae | | |
| *Catopsilia crocale pomona* | | |
| *C. pyranthe* | -do- | -do- |
| Papilionidae | | |
| *Polydorus aristolochiae* | -do- | -do- |
| Nymphalidae | | |
| *Hypolimnas misippus* | -do- | -do- |
| Thysanoptera | | |
| Thripidae | | |
| *Thrips hawaiiensis* | -do- | Entire body |
| Nectariniidae | | |
| *Nectarinia asiatica* | -do- | Bill, Forehead |
| *N. zeylanica* | -do- | -do- |

0800 hrs, the corolla tube gets filled; amount produced was 6 ml/flower. Sugar concentration is 18% and composed of glucose, sucrose and fructose (Gsf); amino acids and proteins are also found.

**Breeding behaviour:** Hand–pollination done to test the various modes of reproduction showed that apomixis is totally lacking, reproduction is by autogamy (100%), geitonogamy (100%) and xenogamy (48% fruit set; 62% seed set; 30% fecundity). Open pollinations also yielded 100% in fruit set and seed set as well as in fecundity.

**Flower visitors' activity:** A total of ten species was recorded at the flowers– two avian species of Nectariniidae, two hymenopterans (bee and ant) and six lepidopterans. Besides these, thrips are also found in the flowers. All these are day—active: sunbirds and ants during 0600–1800 hrs, *Trigona* sp. during 1100–1500 hrs, and the butterflies during 1000–1600 hrs.

Only avian species are consistent and frequent visitors throughout the season. Sunbirds, ants and butterflies visited the flowers for nectar. They emptied the flower in a single visit. The stingless bee *Trigona* sp. visited the flowers for pollen only (Table 1). *Trigona* sits against the stamens and moves onto the anthers and collects pollen; then the stigma and stamens are forced out of the upper corolla lip. Consequently, the pollen falls on the stigma in small clumps and the ventral side of the bee's body brushes against the reproductive parts. *Camponotus sericeus* do not disturb the flower and take nectar from lateral side. The butterflies approach the flower laterally and from the front, to obtain nectar; the reproductive parts come into contact with the proboscis when the butterfly approaches from the front. However, all the visits are not successful.

The sunbirds behave at the flower in two ways: a) they sit at the inflorescence axis, insert the bill into the flower of the side of inflorescence from the front; b) they sit at the inter—verticil region of the inflorescence, and insert the bill into the flower tube from above, through the corolla lip; then the lip is ruptured vertically in the centre. In either case, the stigma and stamens come out of the hooded lip but without any damage to the reproductive parts. The manner of pollen fall on the stigma was the same as occurred when *Trigona* sp. foraged. Two plant species *Anisomeles malabarica* and *A. indica* compete with *Leonotis nepetaefolia* for pollinator service, especially from avian species.

## DISCUSSION

**Pollination:** The flowers are visited by the avian *Nectarinia* sp., the stingless bee *Trigona* sp., the ant *Camponotus sericeus* and butterflies. The sunbirds may reach the nectar either by inserting the bill in the legitimate way (Fig. 1a) or by piercing the upper corolla lip from above, making a vertical slit in the mid—part of the corolla (Fig. 1b). *Trigona* sp. collects pollen sternotribically and the butterflies suck the nectar and seldom effect pollination. The ants forage on nectar and do not establish contact with the stigma and pollen and hence act as nectar robbers. *Trigona* sp. and butterflies are not regular visitors. The birds are regular and consistent and their visits to the flowers force the essential organs out of the upper corolla lip and obtain nectar nototribically, while it is sternotribic for *Trigona* sp. and is seen heavily dusted with pollen upon visiting the flower. The plants reproduce through autogamy, geitonogamy and xenogamy –the first as superior. Controlled pollinations of autogamy indicated 100% success in fruit set and fecundity even in the total absence of flower visitors. When visitors are absent, the pollen, after getting dried, drops onto the stigma, resulting in auto–pollination.

Structurally, the flowers are gullet–blossoms, the stigma and anthers are hidden inside the wooly upper corolla lip; anthers dehisce by longitudinal slits, nectar is abundant, dilute and is well suited for the sunbirds to sip. The lower corolla lip is not well developed and shrivels away soon after anthesis. The sunbirds showed a preference for scarlet *L. nepetaefolia* flowers, when *Anisomeles indica, A. malabarica* (blue flowers) were available at a place, thus suggesting a preference for scarlet flowers. Evidently, *L. nepetaefolia* does not rely on pollinator activity for its reproduction, but certainly such activity may contribute to xenogamy and the resultant genetic variability.

Salim Ali (1932) has compiled a list of plant species pollinated by sunbirds and by others, where members of Lamiaceae such as *Salvia splendens* and *L. nepetaefolia* are given as visited by sunbirds. The present study adds *Anisomeles* sp. to such a list. The *Anisomeles* sp. are not only visited for nectar but are pollinated in their act of foraging.

The sunbirds are known to exhibit site specificity and it seems to be maintained over a long period of time. In certain cases, they probe the flowers in an illegitimate way and sip the nectar (Salim Ali 1932). In the present study, the sunbirds were seen occupying nests in the nearby bushes of *Euphorbia antiquorum* or other plant species and regularly paid visits to a particular patch of *Anisomeles* or *L. nepetaefolia*. The pollination by sunbirds at the study area was not dense, hence there was no competition for floral resource. The sunbirds approached the flowers of *Anisomeles* sp. in the legitimate way, but they usually punctured the corollas of *Leonotis nepetaefolia*.

**Nectar and pollen–ovule ratio:** Heinrich (1975) discussed that the flowers to be pollinated by large bodied animals requiring high energy produce significantly more nectar compared to the flowers pollinated by small—bodied low energy requiring organisms; and most of the outcrossed plants produce relatively large amounts of nectar. Contrary to this, the autogamous *L. nepetaefolia* produced more of diluted nectar similar to that of bird–flowers. The pollen–ovule ratios are also greater as in xenogamous flowers in contrast to the prediction of Cruden (1977) that autogamous species will have lower P/O's than xenogamous flowers. Presumably, the *L. nepetaefolia* autogamous race occurring in India might have descended from a xenogamous bird–pollinated race as suggested by Cruden (1976), but the degeneration of breeding system is not accompanied by a similar degeneration of other floral characters as corolla colour, pollen–ovule ratio and nectar production.

Cruden (1976) suggested the possible lines of evolution of breeding system in *Leonotis nepetaefolia* on the basis of his observations on the populations in the New World. He found the small flowered form as well as the large flowered form and a third form occurring in eastern Africa which has given rise to the weedy populations in southeast Asia, Indonesia, Australia etc. The small flowered form is facultatively xenogamous and is pollinated by hummingbirds and small bees. The large flowered form is xenogamous and is pollinated in Kenya by sunbirds (Gill and Wolf 1975), but in the New World it is visited illegitimately by hummingbirds which take nectar from the flowers by slitting the corolla or depressing it from above. He further states that the large flowered form is recently arrived in the New World and that the evolution of an autogamous race may be occurring. Therefore, it is likely that the form now studied might have originated from a xenogamous race.

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# SATPURA HYPOTHESIS AND THE DISTRIBUTION OF LAUGHING THRUSHES *GARRULAX* LESSON OF INDIA[1]

MD. ANWARUL ISLAM[2]

*(With two maps and a text-figure)*

Several theories have been put forward to explain the discontinuous distribution of Himalayan flora and fauna in the south Indian hills. Tbe present paper discusses one of these theories in the light of an in-depth study of the ecology of Laughing Thrushes carried out between 1982 and 1984.

## INTRODUCTION

The ecology of two south Indian endemic laughing thrushes, namely the Nilgiri Laughing Thrush *Garrulax cachinnans* and the Whitebreasted Laughing Thrush *G. jerdoni*, in the Nilgiri (11°12' N to 11°40' N and 76°14' E to 77° E) and Palni Hills (10°1' N to 10°26' N and 77°14' E to 77°52' E) was studied from May 1982 to mid March 1983 and July 1983 to August 1984. Three and a half months (20 March to 8 July 1983) were spent in the Nainital area, Uttar Pradesh, (29°12' N, 79°29' E) to learn the habitat, ecology and behaviour of laughing thrushes in their strong hold, i.e. the Himalayas, where most species of the genus *Garrulax* occur. In the Himalayas, four species of laughing thrushes were studied, namely the Streaked Laughing thrush *G. lineatus*, Whitethroated Laughing Thrush *G. albogularis*, Whitecrested Laughing Thrush *G. leucolophus* and the Striated Laughing Thrush *G. striatus*.

## OBSERVATIONS AND DISCUSSION

Besides India, laughing thrushes occur in China, Pakistan, Nepal, Bhutan, Bangladesh, Burma, Thailand, Kampuchea, Malaysia and Sri Lanka (Map 1). The genus *Garrulax* comprises 46 species (Zuoxin 1982), of which 28 occur in the Indian subcontinent, mainly in the Himalayas. Of these 28 species, two are endemic: *G. cachinnans* to the Nilgiris and *G. jerdoni* to the Palnis and Kerala hills. The only other laughing thrush occurring in different south Indian hills is the Wynaad laughing thrush, which is a subspecies of the east Himalayan *G. delesserti* (Ali 1977). Only one species, *G. cinereifrons*, occurs in Sri Lanka as endemic, but it is closely related to *G. delesserti* (Ali and Ripley 1972).

The significant occurrence in a few hills of southern India of certain plant and animal forms either identical to or possessing close affinities with east Himalayan, Indochinese and Indo–Malayan forms, has been commented on by earlier biologists. Several theories have been put forward to explain this wide-ranging discontinuous distribution of life forms. Some of these are:

(1) Himalayan glaciation theory, (2) Southern route across the Indian ocean theory, (3) Deccan trap theory, (4) Continuous range theory, and (5) Satpura hypothesis.

The Satpura hypothesis was first postulated by Hora (1937a, 1937b) to account for the presence and distribution of torrential-river fishes of Malayan affinity in the Indian peninsular region, south of the Satpura-Vindhya-Assam Hills trend, in contrast to their supposed absence in the west Himalayan region. For more than 15 years his numerous scientific contributions (Hora 1938, 1949a, 1949b, 1950, 1951, 1952a, 1952b, 1953, 1955; Hora and Mathur 1952, Hora and Menon 1952, 1953) developed the original concepts. He synthesized geological, palaeobiogeographical, palaeontological, palaeobotanical, palaeoclimatological and meteorological evidence for a comprehensive theory governing

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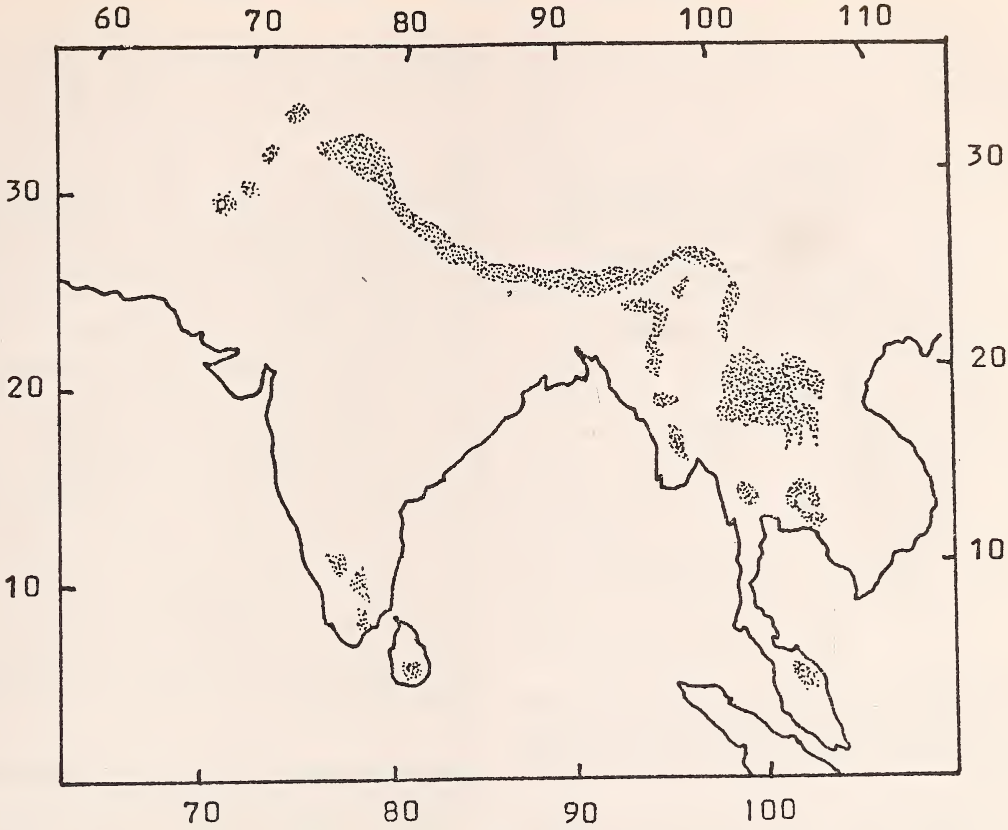


Map 1. Distribution of genus *Garrulax* (shaded portion only, modified after Ali 1953).

tertiary palaeobiogeography, faunal and floral migration and distribution.

Hora's (1937a) first statement on the hypothesis is paraphrased by Sahni (1982) as follows: The rising Himalayas in the region of western Assam and eastern Nepal disrupted the eastward flow of the Indo–Brahm river in the late Miocene which then acted as a barrier to a new stock of hillstream fishes migrating from the east towards India. Unable to cross the barrier, the fishes were deflected southwestwards along the Satpura—Vindhya trend which stretched across India as a pronounced range from Gujarat to the Assam Himalaya. The route followed by the fish immigrants was westward along the Satpura–Vindhya ranges, and thence southwards along the Western Ghats towards the southern extremity of the subcontinent (Fig. 1).

Ali (1949, 1977) supports Hora's Satpura Hypothesis and cites examples in the various groups of animals - mammals, birds, reptiles and amphibians. Ali mentions that many avian genera and species of the eastern Himalayas show a discontinuous distribution similar to that of the laughing thrush genus *Garrulax*, such as Fairy Bluebird *Irena puella*, Great Pied Hornbill *Buceros bicornis*, the two bazas or lizard hawks *Aviceda jerdoni* and *A. leuphotes* and the Rufous-bellied Hawk–Eagle *Hieraaetus kienerii*.

The most striking example among the avifauna is provided by the laughing thrushes of the genus *Garrulax*. Ali explains the origin of these relics, on the assumption that in the geological past there was a direct elevated land connection between the Himalayas and the southern hills, providing the requisite physiographical conditions for a con-

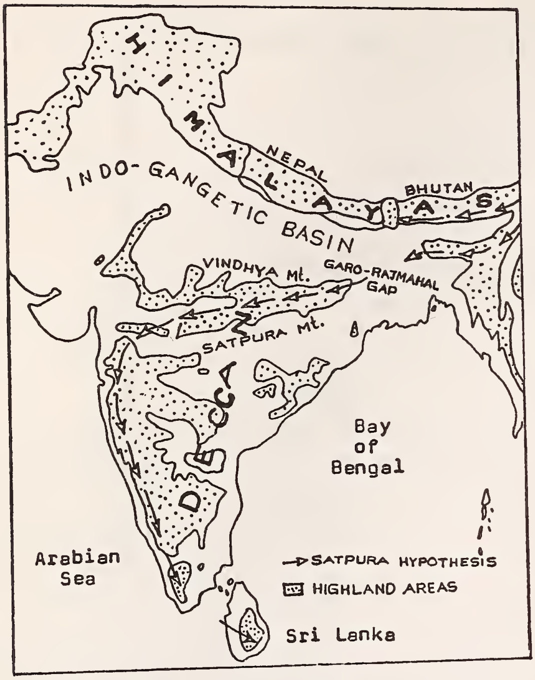
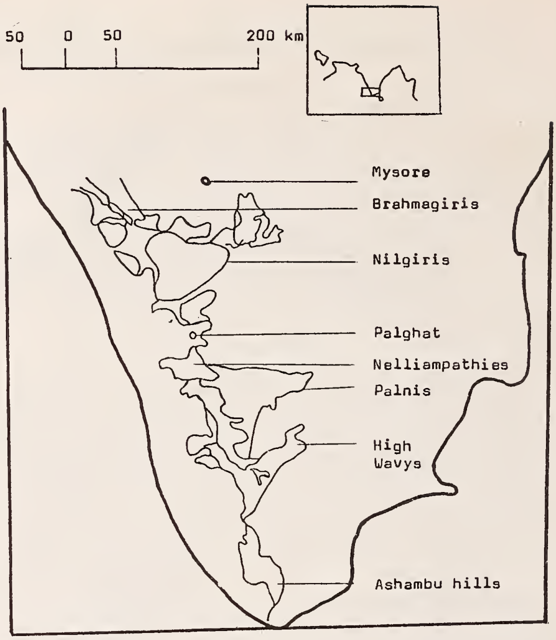

HIMALAYAS
NEPAL
BHUTAN
INDO-GANGETIC BASIN
VINDHYA Mt.
GARO-RAJMAHAL GAP
SATPURA Mt.
DECCAN
Bay of Bengal
Arabian Sea
SATPURA HYPOTHESIS
HIGHLAND AREAS
Sri Lanka

**Fig.1** Sketch map of India illustrating Satpura Hypothesis of Hora. Arrows indicate the supposed migration routes of torrential river fishes (Source: Sahni 1982, modified after Hora 1953).

tinuity in their distribution. Through the action of geotectonic forces–subsidence and erosion–the connecting land 'bridge' disappeared. The more stable sections were cut off from the Himalayas as 'islands' thus marooning the local populations of plants and animals on them, including weak–flying sedentary birds like the laughing thrushes, in a sort of natural refugium.

However, Dey (1949) asserts that it is impossible, on available evidence, to accept the idea of a belt of hills across the Bengal (Rajmahal) gap, Chota Nagpur etc. within the time— range of living animal species. Auden (1949) is also not in favour of the probability of the existence of the continuous Satpura ranges.

If, as suggested by Dey (1949) and Auden (1949), there was no continuous elevated land connection between the Himalayas and the south Indian hills, then the laughing thrushes could not have migrated southward over the Satpura-Vindhya mountains. On the other hand it would seem more likely for them to have spread over the continuous western Himalayas.


50
0
50
200 km
Mysore
Brahmagiris
Nilgiris
Palghat
Nelliampathies
Palnis
High Wavys
Ashambu hills

Map 2. Locations of the hilly areas of the Western Ghats (Source: Khan 1977).

Moreover, the Satpura Hypothesis is unable to account for the following three facts regarding the present distribution and ecology of the southern laughing thrushes.

1. *G. cachinnans* is restricted to the Nilgiris, whereas *G. jerdoni* is found in the Brahmagiris, north of the Nilgiris, and Palnis, High Wavy and Ashambu hills, i.e. south of the Nilgiris. It is very unlikely that *G. jerdoni*, which is found in the Brahmagiris, completely by passed the Nilgiris on its passage towards the Ashambu hills (Map 2). If these birds had migrated through the Satpura-Vindhya mountain trend, the two endemic laughing thrushes *G. cachinnans* and *G. jerdoni* would have appeared together, at least in certain hills in the Western Ghats, particularly in the Nilgiris.

An in–depth study of the south Indian endemic laughing thrushes *G. cachinnans* and *G. jerdoni* has shown that both species have almost identical ecological requirements. Then the question arises as to what factors prevented these two endemic species from coexisting in any of the Western Ghats hills in their range. Gause (1934) states that two species cannot coexist unless they are occupying two different niches.

Let us assume that due to identical niche preference these two species could not coexist. However, Perrins and Birkhead (1983) remark that closely related bird species often differ in one or more niche dimensions within a community. According to them the following might happen if two species with identical niches arrived in the same place: (1) They might coexist without deleterious effects. This is a possibility only if the resource is temporarily unlimited. (2) One or other species may be more efficient at harvesting a limited resource. In this case, either the less efficient species will become extinct, or it will change its niche. In cases where coexistence occurs it is unlikely that one species would change its niche completely and that the other would not change at all. It is more likely that each will be slightly more efficient than the other in different parts of the niche. If so, what would happen is that both species would alter their niches accordingly.

MacArthur (1972) points out that it is easier for two similar species to coexist than for three or more. This is because in the former situation each species has the chance of shifting its niche away from that of the other. With three or more species, this may not be possible for the species occupying the middle part of the resource. Furthermore, either each species maintains its niche and there is a considerable overlap between adjacent species, or each species narrows its niche. Hence, if the southern laughing thrushes had migrated through the Satpura–Vindhya trend, the coexistence of these two species would have appeared in some of the south Indian hills they inhabit. In the Himalayas several species of laughing thrushes do coexist.

2. The south Indian laughing thrushes are believed to be relict populations of Himalayan forms. Previous workers found the Himalayan species of the genus *Garrulax* to be chiefly group—living or gregarious birds. However, the present study reveals that the two endemic south Indian laughing thrushes are chiefly pair—living. If the south Indian populations are an offshoot of their group—living Himalayan congeners (author's experience of the Himalayan species is confined to the breeding season when *G. lineatus* and *G. striatus* were found only in pairs), the territorial strategy would have shown a different picture of their survival. Gaston (1980) states that an individual of a pair—territorial species can switch to group—territoriality without loss of fitness in terms of its pre—existing reproductive and feeding behaviour, but an individual of a group—territorial species which adopts a pair—territorial strategy may suffer in adaptations to feeding, predator detection and nest—site selection which reduces its fitness in a pair—territoriality. However, the nesting success of the southern endemic laughing thrushes appeared to be high which is an indication of how well they are adapted in their present distribution.

3. Furthermore, the complete absence of the Sri Lankan endemic laughing thrush, *G. cinereifrons* in the Western Ghats is again puzzling as it too would have migrated along the Satpura—Vindhya mountain trend. Although Jacob (1949) states that Sri Lanka remained geographically a part of the Indian mainland until quite recent times and supported Hora's Satpura Hypothesis, he admits that he has no direct geological evidence in support of the hypothesis to explain the existing distribution of the flora and fauna. Moreover, concerning the land connections between India and Sri Lanka, the common belief is that the last separation is as recent as *c.* 10,000 years ago, but the real disappearance of the Gulf of Mannar would, according to Blasco (1970), date from the commencement of the Pleistocene; and there is apparently nothing to prove that there was in its place a high mountain.

These unexplained facts do not fully credit Hora's concept (supported by Ali) of a physical corridor which enabled the southward migration of the laughing thrushes.

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# ADVANTAGES OF COMMENSALISM IN *ULOBORUS FEROKUS* BRADOO (ARANEAE: ULOBORIDAE)[1]

B.L. BRADOO[2]

*(With three plates containing six figures)*

The paper gives an account of commensalism among spiders, and its advantage to a non–poisonous spider *Uloborus ferokus* Bradoo (Araneae: Uloboridae), which lives as a gregarious commensal on the web sheets of the social spider *Stegodyphus sarasinorum* Karsch (Family Eresidae).

## INTRODUCTION

The commensalistic association among spiders has received very little attention. The information available in the literature is based on some general observations, giving records of the association of one species with another. The actual biotic relationship involved between the two species has not been thoroughly investigated. The detailed study on the life–history and biology of commensal spiders forms an interesting and valuable field of arachnid ecology.

The various aspects of the biology of *Uloborus ferokus*, a gregarious commensal that lives on the web sheets of the social spider *Stegodyphus sarasinorum* have previously been described (Bradoo 1972a, 1979, 1985; Patel & Bradoo 1981). Studies on the ecology and behaviour of its host has also been reported earlier (Bradoo 1972b, 1975a, 1975b, 1980).

This paper gives an account of the various benefits and advantages that *U. ferokus* derives from commensalistic association with the social spiders.

## METHODS OF STUDY

The observations recorded here are based on extensive field studies and laboratory observations on these spiders. Nests of *S. sarasinorum* bearing these commensals were collected from the field and installed near the laboratory, for experimentation and observations. For detailed techniques, previous publications by the author should be consulted.

## COMMENSALISM AMONG SPIDERS

Details and reviews on commensalism among spiders are not available, except for a brief note by Kaston (1965). Because of the insufficient observations, some species of spiders have often been recorded as parasites in a host web, and as commensals in the webs of some other spiders. Kullmann (1959) cites several authors like Comstock, Kukenthal and Vinson, who reported commensalism among a few spiders. However, true commensalistic association among spiders is rare, and so far known from only three different families, namely Oonopidae, Theridiidae and Uloboridae.

Under the family Oonopidae, Bristowe (1958) records that *Oonops pulcher* lives among the retreat fibres of the large spiders like *Amaurobius ferox* and *Tegenaria atrica*, and feeds on the remains of its host's meals.

Under the family Theridiidae, Simon (1894) reported *Theridion nodiferum* in commensalistic association with the tropical psechrids. The best known account of commensalism has been given by Exline (1945) for the conopisthine spiders that live on the webs of other spiders. She found 23 individuals of three different species of *Argyrodes* in the webs of different species of *Gastracantha.* Yaginuma (1956) reported *Rhompheae sagana* and *R. fictilium*, in commensalistic association

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with the webs of *Linyphia, Araneaus* and *Fontinella*, in Japan. Lamore (1957) found *Conopistha trigona* as a commensal of *Allepeira lemniscata*, in Maryland, U.S.A.

Legendre (1960) reports that one or many commensals may be found on the same host web, and he found upto 50 individuals of *Conopistha zonatus* in a single host web. Tembe and Thakur (1960) found specimens of *Argyrodes nephilae* in similar association with *Nephila maculata*, from India. This commensal feeds on very minute insects that do not attract the attention of the host spider. Bradoo (1983) recorded *A. progiles* in association with *Stegodyphus sarasinorum*, from Kerala.

Exline and Levi (1962) reported that some, perhaps all, the species of the genus *Argyrodes* live as commensals in the webs of larger spiders like *Nephila, Gastracantha, Argiope, Latrodectus, Agelenopsis* and *Allepiera.* Often, many individuals of different species of *Argyrodes* live on a single host web and feed on small insects that get ensnared in the host web. Hence, these small commensals may not construct any web of their own, or may sometimes construct a typical theridiid web consisting of only a few silk lines, close to or on the host web itself. These commensals hang in the host web upside down, with the first pair of legs folded beneath the body. They are usually inconspicuous, being smaller than the host and resemble some seeds, bits of bark or some plant matter attached to the host web. It is believed that conopisthine spiders may live in any convenient web as commensals.

The commensalistic association and nature of *Conopistha* has been questioned by Wiehle (1928), Thomas (1953) and Kullmann (1959) who consider that *Conopistha* is an obligate parasite, because it feeds on the prey that could be used by the host spiders also. Kullmann (1959) further points out that *C. argyrodes* steals wrapped prey held in reserve in the web by the host spiders like *Zygiella x–notata* and *Cyrtophora citricola.* Kullmann (1960a, b) found that *Theridion tepidariorum* lives as a parasite in the web of *Cyrtophora citricola.* The observations of Darchen (1965) are interesting in that he found that *Cyrtophora* species in Gabon steal captured insects from other orbs of larger spiders. Vollroth (1979) describes the behaviour of the kleptoparasitic spider *Argyrodes elevatus* from Panama.

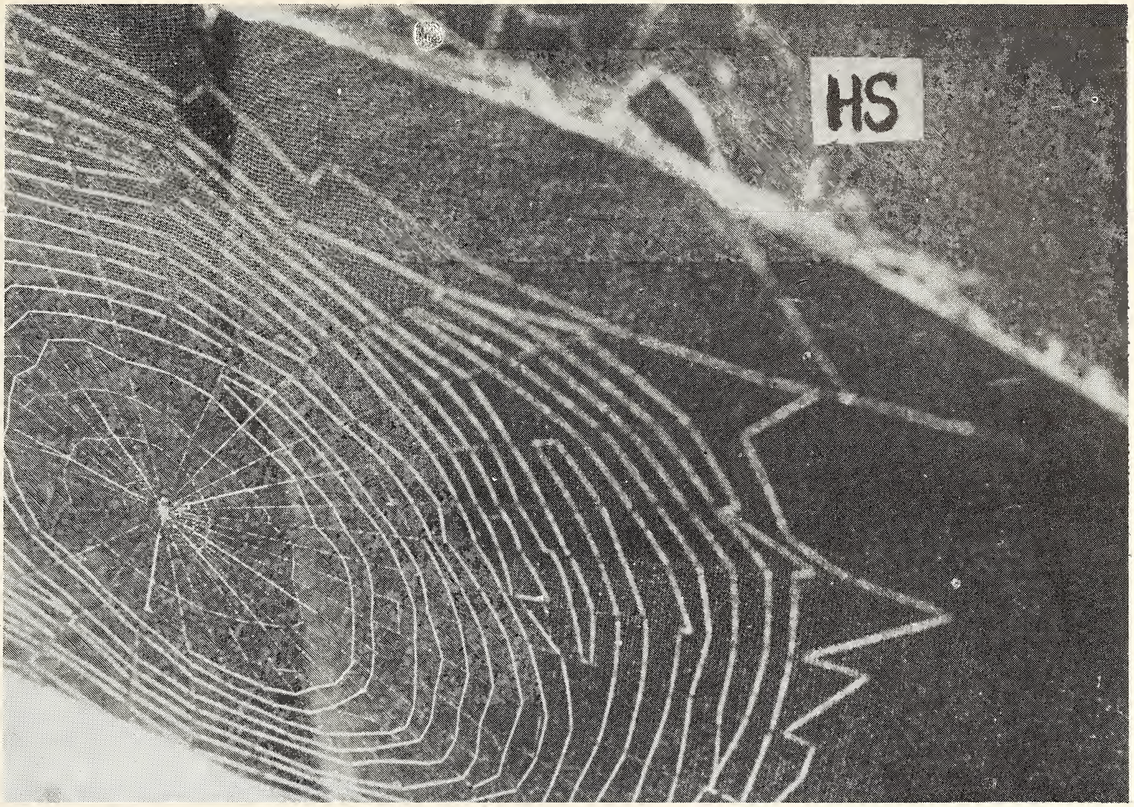
Kaston (1965) is of the opinion that the variation in the behaviour of conopisthine spiders is possibly due to their non–host specificity, and hence their behaviour seems to be so plastic and variable that in one host, they behave as a commensal, and in another they lead the life of a parasite. These observations may, however, help in understanding the origin of aggregations, commensalism, kleptoparasitism and true parasitism among spiders that are basically aggressive and cannibalistic.

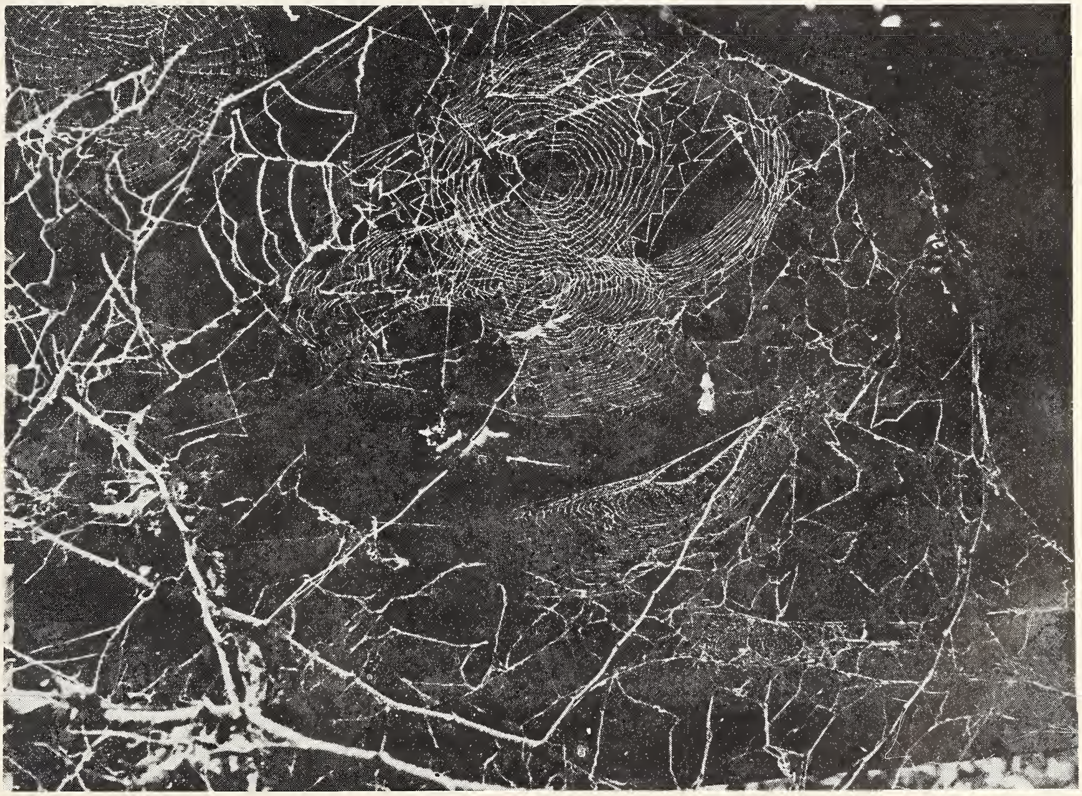
Under the family Uloboridae, Simon (1892) reported *Uloborus servulus*, in commensalistic association with a *Cyrtophora* sp. in Venezuela. Gravely (1915, 1921) found a *Uloborus* species (unidentified) in commensalistic association with the social spiders, at Cochin, and recorded other unnamed species of these spiders from the webs of *Cyrtophora cicatrosa, Gastracantha brevespina* and *Nilus* sp., from Barkuda Island, and from the webs of *C. citricola*, from Burma.

Struhsaker (1969) reported *U. mundior* in association with the larger spiders like *Nephila clavipes*, in Panama. Opell (1979) reported colonies of *Philoponella tingena* in the webs of *Achaearaneae, Scytodes* and *Nephila*, in Panama and Colombia. Bradoo (1979) reported *U. ferokus*, a gregarious commensal that lives on the web sheets of *Stegodyphus sarasinorum*, in Kerala. This association serves many benefits and advantages to the commensal, but not at the expense of the host spiders. The host spiders are not at all harmed or affected in any way by the commensals, which are of very small size.

## ADVANTAGES OF COMMENSALISM

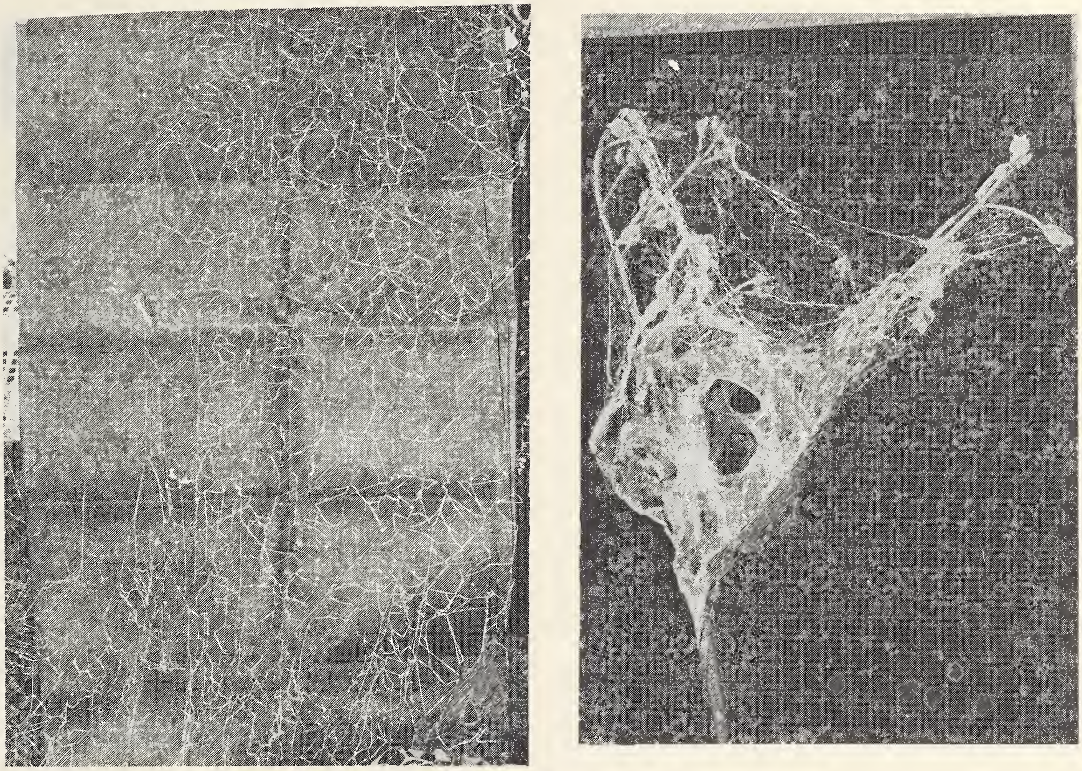
**1. Support and protection:** *Uloborus ferokus* is a gregarious, non—poisonous, orb making spider. Its orb webs are supported by the host web sheets or are made between the host nest and the adjacent





*Above*: An orb web of *Uloborus ferokus*, supported by he host silk threads (HS).
*Below*: Orbs of the commensal as seen in the damaged reas of the host web.

*Above*: The *U. ferokus* female with her cocoon.
*Below*: The nest and the damaged web sheet with a host spider.



*Left* : Close-up of freshly made host web sheets showing sticky, zig-zag cribellar threads.

*Right* : A typical host nest with reduced web sheets during the breeding season of the host spiders. The nest shows interconnected tunnels inside.

web sheets (Plate 1). Usually, the commensals make their orbs among the damaged web sheets of the host (Plate 1). Even the newly hatched spiderlings of this commensal prefer to spin their primary and tiny orbs in the vicinity of the host nest, or they may stay close to the host nest without spinning any orbs. The host nest and the web sheets thus not only support a large number of these commensals (maximum up to 54 individuals were observed in a single, large host web), but also protect these commensals against unfavourable weather conditions such as rain, strong wind and sunlight.

**2. Nourishment:** Due to the weak and fragile structure of their orbs, and secondly as a result of active struggle of some prey, the tiny orbs of these commensals get badly damaged. Although the orbs are made daily in the morning, the damaged orbs are not repaired, so that the commensals are forced to live on the host web itself to obtain the necessary nourishment from it. The host web not only supplies nourishment, but also provides a resting place and shelter for the webless commensals. The gravid females and mature males of *U. ferokus* do not spin any orb webs of their own but prefer to stay close to the host nest, or on the web sheets.

During maternal care, which may last up to ten days, the mother stays with her cocoon (Plate 2) and normally does not spin her orb web, particularly during the dry season. During this period she gets her nourishment exclusively from the host web.

*U. ferokus* commensals have a double advantage of getting their nourishment from two sources: (a) from the host web, and (b) from their own orbs when present. However, the host web is the chief source of nourishment available in the form of minute insects. These include microhymenoptera, microdiptera, minute beetles, Staphylinids and other insects like thrips, aphids and a variety of small winged insects, that are available throughout the day and night. Such minute insects are insignificant for the nutritional requirements of the host spiders that feed on larger insects only (Bradoo 1980).

**3. Activity:** That the host web serves to supply the necessary food at any time of the day and night, keeps the commensals active all the time, unlike other spiders, that may be either nocturnal or diurnal in activity.

**4. Economy in spinning activity:** A continuous supply of prey items from the host web does not make it obligatory for the commensal to repeat another orb on the same day, nor does it need to repair its badly damaged orb, unlike other orb—spinners that depend exclusively on their orb, which needs care and regular repairs. The experimental individuals of *U. ferokus* that were prevented from making any orb continued to live on the host web till maturity. Thus the orb in this spider seems to be a useful device to perceive the vibrations coming from the host web. It serves as a resting place from which it can monitor very effectively the web vibrations that come from the nearest area of the host web.

The orbs of *U. ferokus* do not withstand the struggles of various active prey items, particularly the Staphylinids, that manage to escape even before the commensal is able to restrain and wrap them (Bradoo 1986). The escape potential of these prey from the orb is further facilitated by the fact that these commensals, being non–poisonous, do not bite their prey to death, either before or after the prey–wrapping is over. Therefore, it takes much more time for the commensal to subdue and restrain an active prey in the orb than in the host web.

On the other hand, the host web is highly sticky, elastic, and an efficient trap for all types of insect prey, small or very large in size. Thus minute prey get no chance to escape from the host web. This nourishment is easily available and procured by the commensals that have to exert themselves very little in the host web.

**5. Growth and life history duration:** A continuous and abundant supply of food from the host web accelerates the growth and the life history of these commensals. Unlike most other orb—weavers, that have an annual or a biennial life history, the *U. ferokus* commensal completes its life history in 54 to 79 days. This comparatively short duration is accountable in terms of the benefits it derives from its association with the social spiders.

Not only is the life history short, but there are five to six generations each year, and these generations overlap. The breeding throughout the year is a unique feature of its biology. Hence, all the stages from egg (cocoons) to adult spiders are available on the host web all the year. However, the number of commensals is directly related to the life history of the host spiders and the size of their web–sheets.

**6. Reproductive success:** The commensalistic association also serves to keep mature males and females together on the host web. Hence, it is easier for males to locate mature females for mating. The number of males is understandably lower than the females, which is compensated by their habit of staying on the host web, and secondly by the fact that males of this species practise polygamy and get their mates easily during their exploratory behaviour on the host web. Hence, every female individual is positively impregnated, and this helps to increase their reproductive success.

**7. Increased fecundity:** The reproductive success is also enhanced markedly by the increased fecundity as a result of availability of more prey from the host web. Each *U. ferokus* female makes a total of up to four cocoons in the wet season, at an interval of 5 to 17 days. Prey is more abundant during the wet season. But in the dry season, just one cocoon is made by each female on account of the shortage of prey (Patel & Bradoo 1981).

**8. Regulation of populations:** The commensals adjust their breeding activity with the life history of the host spiders, that reproduce only once, in summer. The number of host spiders is then low, and a corresponding decrease is observed in the commensals. The web sheets are very much reduced and damaged (Plate 2). But with the approach of the wet season, the host population and the web sheets increase in size so that the commensals also increase in number. The host web size serves to regulate the population of the commensals.

**9. Dispersal:** The dispersal of the commensal to new host nests is brought about by the host web (Plate 3) which joins several nests with each other. Newly hatched *U. ferokus* spiderlings show a geonegative behaviour. They move upwards over the host web and reach new nests. This prevents overcrowding of the commensals in a single host nest.

**10. Protection against egg–parasites:** The host nest (Plate 3) and web sheets help to reduce the ovipositional activity of the egg—parasite *Idris* sp., so that the cocoons are made closer to the host nest, particularly during the dry season. This prevents parasitism of the eggs and increases their chances of survival. Most other free living uloborids prefer to suspend their cocoons in the orb web, exposing these to various predators and parasites.

**11. Safety to weaker individuals:** *U. ferokus* being gregarious, several individuals live on the same host web. These individuals are of different age groups. The commensalistic life is advantageous to those individuals that make no orb of their own but manage to dislodge and replace a weaker individual from its own orb by web—replacement. This behaviour is not uncommon in these commensals. Those individuals that are replaced, explore the host web and get shelter and nourishment from it. Hence, web replacement need not force a weaker individual to repeat the laborious job of spinning a fresh orb for itself; alternative accommodation on the host web can be used. It is possible that this behaviour might have given rise to gregarious commensalism in this species.

**12. Host's helping behaviour:** Those cocoons of the commensal that remain unattended on the host web may be collected by the host spiders during their exploratory behaviour. Once they come across an unattended cocoon of the commensal, they transport it safely to their nest without damaging or dropping it to the ground, which is normally not done to other inanimate objects on the host web. This interesting behaviour on the part of the host unknowingly protects the eggs or the young ones present in the cocoon. This behaviour can be explained by the fact that social spiders are in the habit of removing and cutting bundles of dry silk from their webs; these are rolled into a ball and incorporated into the nest structure.

For leading a commensalistic life on the host web, these spiders are suitably adapted to move easily on the host web. They do not get entangled even when dropped on a freshly made smare. They seem to show some innate familiarity with the host web. They also help to keep the host web clean by eating minute prey that is not required by the host. Thus the commensals also act as 'web—cleaners' for the host spiders. Their feeding activity does not disturb the host spiders, as they cut the web around the ensnared prey in the host web. At the approach of any host spider, the commensal stops all its movements and if necessary, can run quickly to safety on the host web or via a dragline to its own orb. Hence, *U. ferokus* behaves and lives like a true commensal and its association is not at all harmful to the host, nor does it live at the expense of the host.

To summarize, therefore, *Uloborus ferokus* lives in commensalistic association with the social spider *Stegodyphus sarasinorum.* The web sheets of the host spider provide protection, support and plenty of nourishment in the form of minute prey. This increases the fecundity, longevity and population of the commensals. The commensal breeds throughout the year and the duration of life history is short. There are several generations per year and the generations overlap. Males, gravid females and those that are replaced by stronger individuals live on the host web, which enhances the reproductive success of the commensal. The host nest and the web sheets not only support the orbs of these commensals and their cocoons, but also prevent the ovipositional activity of the egg—parasites. It also helps in the dispersal of the commensal.

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# OBSERVATIONS ON THE BIOLOGY OF THE PRAYING MANTIS *CREOBATER URBANA* FABR. (ORTHOPTERA: MANTIDAE)[1]

R.J. RANJIT DANIELS, MALATI HEGDE AND C. VINUTHA[2]

Observations on the biology of a species of Indian mantis, namely *Creobater urbana* Fabr. have been discussed in the text. The egg laying interval was predictable. The data shows a gradual decrease in the number of young that hatched out irrespective of the size of the ootheca. The species does not appear to be parthenogenetic. The life–history of the young has also been discussed. A parasite on the ootheca of mantises was identified. Coexistence of ants with developing praying mantis embryo inside the ootheca was also noticed.

## INTRODUCTION

Praying mantises are known for their subtle way of hunting and their total dependence on live animal food. This quality has attracted attention towards using them as insect predators. *Creobater urbana*, one of the more than 1800 species of mantises in the world, is a medium sized mantis found commonly in Bangalore. Individuals are seen on bushes and are often attracted by light. However, not much is known about its biology. In this paper we discuss observations made on its food preference, egg laying behaviour and life—history.

**Food:** An adult *C. urbana* female was brought to the laboratory on 31 July 1983. It was maintained in a transparent polythene cage and readily accepted most of the insects offered as food. Table 1 shows the variety of insects it either took or rejected. It lived for 4 months and died on 30 November 1983. During the first month it was fed every day with one or more of whatever kind of insects were available. Later, due to difficulty in getting insects, it was fed every alternate day. A few like the *Danaus*, the common Aristolochia butterflies and a species of wingless grasshopper, were caught, tasted and rejected. The butterflies are known to carry toxins in their bodies acquired from the plants on which their larvae feed. The grasshopper too was unacceptable.

Mantises are normally ambush hunters. This was actually what we observed though at times, when very hungry, our mantis used to search and take the prey. This behaviour has been reported by Inoile and Matsura (1983) as 'active searching'.

**Egg–laying:** On the third day after it was brought to the laboratory, the female mantis produced an ootheca (egg). More oothecae were produced at predictable intervals (Table 2) and before it died 11 oothecae were produced. It preferred to lay on wood and would not lay on the smooth sides of its polythene cage. The interval between the second and third ootheca was increased by a day as no branch was provided. On providing a branch it immediately got on to it and laid.

The normal pre–laying behaviour that we observed was non–acceptance of food for at least a day before the act. The mantis would be dull and inactive. This was a clear indication of laying.

Often the branch was provided on seeing this behaviour. The mantis always took an upside down posture while laying, pushing the frothy white egg mass upwards. The white frothy mass dries into a creamy white hard ootheca. After the process was completed, the branches were taken out, the oothecae measured for length, labelled and maintained in separate cages. The mantis usually fed after laying.

The laying interval (Table 2) was 7 days initially. It then abruptly increased to 10 days and gradually from 10 to 15 days before the mantis died. The mean number of days 9.1± 1.9 was calculated excluding the last interval of 15 days.

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(Details of the last ootheca have not been included in calculating means as by then the mantis was worn out and had become very dull and inactive.) The sudden change in the laying interval from 7 to 10 days can be related to the change in food availability. When fed every day, the interval was 7 days (except between the second and third) and when fed every alternate day it became 10 days. Mastura and Morooka (1983) also claim that with more food, the interval between ovipositions is shortened. The egg size they say was nevertheless fixed in the mantis *Paratenodera angustipennis*. This tendency has been observed in the mantis *C. urbana* too as the mean egg length was 31± 3.4 mm with a variation of only 10.9% compared to the 20.8% variation in the laying interval. Ageing may also have affected the interval, particularly between the last 2 or 3 eggs.

All the eleven oothecae hatched. The mean time taken was 33.5± 2.5 days (CV 7.4%, Table 2). The number of young was 45.3± 12.2 per ootheca with a variation of 26.9%. This variation is much higher compared to the variation in ootheca length (CV of 10.9%). The data shows a gradual decrease in the number of young that hatched out irrespective of the size of the ootheca. This is not easy to explain. Nevertheless there is a possibility of a reduction in the number of viable

TABLE 1

LIST OF INSECTS FED TO THE MANTIS *Creobater urbana*

| Accepted | Rejected |
|---|---|
| **Adults** | |
| Diptera | Wingless grasshopper |
| Mantis (*Humbertiella* sp.) | (Orthoptera: Acrididae) |
| Lymantrid moths (Lepidoptera) | |
| Geometrid moths (Lepidoptera) | *Danaus* sp. |
| (Lepidoptera: Danaidae) | |
| *Polytela gloriosae* | |
| (Lepidoptera: Noctuidae) | *Tros aristolochia* |
| (Lepidoptera:Papilionidae | |
| ARCTIIDAE (Lepidoptera) | |
| *Hypsa ficus* (Lepidoptera: Hypsidae) | *Polydorus hector* |
| (Lepidoptera: Papilionidae) | |
| *Achoea janata* | |
| (Lepidoptera: Noctuidae) | |
| Grasshoppers (Orthoptera: Acrididae) | |
| Katydids (Orthoptera: Tettigonidae) | |
| *Asura conferata* (Lepidoptera: Lymantridae) | Parellelia algira (Lepidoptera: Noctuidae) |
| Corcyra cephalonica (Lepiodoptera: Pyraustidae) | |
| Crickets (Orthoptera: Gryllidae) | |
| *Eurema hecabe* (Lepidoptera: Pieridae) | |
| Catopsila sp. (Lepidoptera: Pieridae) | |
| Lycaenidae (Lepidoptera) | |
| **Nymphs** | |
| *Bracon hebetor* | |
| (Hymenoptera: Braconidae) | *Prenolepis longicornis* |
| *Drosophila melanogaster* | (Hymenoptera:Formicidae) |
| LYCAENIDAE (Lepidoptera) | |

sperms stored in the spermatheca with increasing age of the insect. Though parthenogenesis is known in praying mantises (Mani 1968) we believe that the female was inseminated before it was brought to the laboratory. It refused to mate in the laboratory and both the males introduced on different occasions were killed. The number of oothecae it produced before it came to the laboratory is also not known. A preadult nymph that moulted into an adult female in the laboratory did lay eggs but none hatched. This insect surely had not mated. This supports our view that the species is not parthenogenetic.

**Life history:** Eggs hatched into brown, ant—like young. They were very active, always carrying the abdomen curled up. This persisted till they got their wings. The first batch that hatched out did not survive for more than two days. The other ten were able to survive and a few became adults. Most of the young were released due to difficulty in maintaining them. The ones that we maintained were observed carefully. They started feeding on the third day. They readily caught and ate the tiny hymenopteran parasite *Bracon hebetor* (Braconidae). Later Drosophila, and gradually, as they grew, moths of *Corcyra cephalonica* and lycaenid butterflies were accepted (Table 1). The first moult was observed 2 weeks after hatching and subsequent moults had intervals of 9 to 20 days. In about 77 days a few became adults after 6 moults. Adults are green with a yellow eye—spot on the wings. The change of colour from brown to green took place after the second or third moult. Mortality was generally high during various stages of development. Cannibalism was also observed. Adult longevity is not known.

A few other species of mantises kept in the laboratory at the same time have yielded some interesting information. Two large oothecae were brought to the laboratory. These had been colonised by small colonies of ants belonging to the genus *Crematogaster*. The ants were fed and maintained. Ten days later about a hundred praying mantises hatched out of one of the oothecae. The ants started attacking them and had to be separated. Many died at various stages of development; only one nymph became an adult. It moulted eight times and took 108 days. The

TABLE 2

EGG—LAYING, OOTHECA SIZE AND NUMBER OFNYMPHS HATCHED IN *Creobater urbana*

| Sl. No. | Date of laying | Laying interval (days) | Length of ootheca (mm) | Date of hatching | Time taken to hatch (days) | No. of nymphs hatched |
|---|---|---|---|---|---|---|
| 1. | 3 Aug 83 | – | 33 | 6 Sep 83 | 34 | 53 |
| 2. | 10 Aug 83 | 7 | 30 | 12 Sep 83 | 33 | 54 |
| 3. | 18 Aug 83 | 8 | 37 | 20 Sep 83 | 33 | 50 |
| 4. | 25 Aug 83 | 7 | 29 | 28 Sep 83 | 34 | 53 |
| 5. | 1 Sep 83 | 7 | 32 | 6 Oct 83 | 35 | 60 |
| 6. | 11 Sep 83 | 10 | 31 | 14 Oct 83 | 33 | 42 |
| 7. | 21 Sep 83 | 10 | 33 | 23 Oct 83 | 32 | 40 |
| 8. | 1 Oct 83 | 10 | 27 | 30 Oct 83 | 29 | 43 |
| 9. | 12 Oct 83 | 11 | 33 | 14 Nov 83 | 33 | 42 |
| 10. | 24 Oct 83 | 12 | 25 | 2 Dec 83 | 39 | 16 |
| 11*. | 8 Nov 83 | 15 | 14 | 20 Dec 83 | 42 | 10 |
| Mean | | 9.1 | 31 | | 33.5 | 45.3 |
| SD | | 1.9 | 3.4 | | 2.5 | 12.2 |
| CV % | | 20.8 | 10.9 | | 7.4 | 26.9 |

Has not been included in calculation of mean adult was large and straw coloured. The identity of this species has not been determined. Out of the other oothecae more than twenty hymenopteran parasites of the genus *Podagrion* (Chalcidae) emerged, followed a few days later by praying mantis nymphs. A few were raised and one became an adult female after 7 moults (198 days). It lived for 2 months and then died. The mantis has been identified as *Heirodula* sp. *Humbertiella* sp., a bark—dwelling mantis. Eggs were laid, and took 32 days to hatch; about 60 nymphs emerged from each ootheca.

It has been reported that mantises moult 3–12 times before they become adults (Mani 1968). Our observations have shown a remarkable variation in the time taken to become adults in the three species. The chalcid wasp is considered to be a common parasite on the ootheca (Mani 1968). The co—existence of *Crematogaster* ants with the developing mantises inside the oothecae has also been noted by Lefroy (1909).

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# ECOLOGICAL ASPECTS OF THE LIFE-HISTORY OF THE HIMALAYAN NEWT, *TYLOTOTRITON VERRUCOSUS*(ANDERSON) WITHREFERENCE TO CONSERVATION AND MANAGEMENT[1]

TEJ KUMAR SHRESTHA[2]

*(with two plates)*

The life—history of the Himalayan Newt *Tylototriton verrucosus* is described. Populations of the newt living in far eastern Nepal were used for life—history studies. Newts appeared in rock pool for courtship activities soon after the first rains during spring (February to March) and remained there throughout the rainy season (June to September). As the water level receded from rock pools during late October they abandoned the pools and migrated out to lead a terrestrial life. From November to January they underwent hibernation. For hibernation dead tree trunks, subterranean water and fissures in stream beds were used. It was observed that sustained rain triggered mating activity and ovulation. The mating calls of breeding newts were also noted, which were a low, distinct *twak, twak.* Courtship, mating and egg- laying activity was noticed in May, varying annually. In many respects, the reproductive mode of *T. verrucosus* is like that of *Pleurodeles.* Prescriptions for conservation and management of different life—history stages are given and development of newt sanctuaries is suggested.

## INTRODUCTION

The Himalayan Newt *Tylototrion verrrucosus* (Anderson) occurs in the humid forests of eastern Nepal. Larvae and transformed individuals occur during September and January respectively in small rock pools. Transformed individuals are found tiding over the severe winter in small rock pools, creeks and wallows made by buffaloes. Favourite hiding places for the hibernating adult are underground water courses in rock rubble of creeks, fissures in streams, cracks in wet paddy fields, and dead tree trunks near rock pools.

Anderson (1871) described the newt from western Yunnan. Annandale (1908) reported on their breeding habits. Smith (1924) described tadpoles of the newt from Darjeeling. Chaudhari (1966) gave some information on their habits and behaviour. Gyi (1969) reported the Himalayan Newt from Burma and made interesting comments on its biology. Soman (1966) reported it from Nepal. Mansukhani, Julka and Sarkar (1976) reported the occurrence of newts from Arunachal Pradesh and provided some interesting field notes about their habitat. Ferrier (1974) studied embryonic development of the Himalayan newt in the laboratory. Shrestha (1984) gave a detailed account of the distribution and habitat of the newt in Nepal. The ecological aspects of the life—history of the Himalayan newt's natural environment in Nepal has not yet been described in detail by earlier investigators. Therefore, an attempt is made in the present paper to describe the life–history of the Himalayan Newt so as to throw more light on the conservation and management of this species in nature and in captivity.

## STUDY SITE

The first study site is located in Dhankuta (26° 59' N, 87° 27' E) in the Koshi Zone of western Nepal. The common natural vegetation at this elevation (1160 m) is *Quercus lamellosa, Q. semicarpifolia, Q.lineata, Q. glauca, Lindera, Lithocarpus panchyphylla* etc. In the highland pastures near Hilae village of Dhankuta there are varied species of *Primula, Rhododendron, Machilus.* Among exotic weeds *Eupatorium glandulosum* and *Lantana camera* are grown near pastureland rock pools. Generally, *Pinus rouxburgii* and *P. wallichiana* constitute the over-

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storey vegetation of the study area. The understorey vegetation is composed of *Daphene bholua, Arundinaria hookerina, A. falcata, Diplopterigium volubilis*, and *Nephrolepis cordifolia.* This area receives 604 mm precipitation per year and has a mild, wet winter and warm, wet summer. The maximum and minimum temperature in winter (January) were 16.6°C and 7.7°C respectively; and in summer (July), 29.6°C and 26.3°C.

The second study site is Mai Pokhari which lies in Ilam district of Mechi Zone (26°55' N; 87°54' E). The natural lake lies at the elevation of 1300 m and covers about 175 hectares. The margin of the lake is forested with varieties of plants as described above. The forest here is relatively undisturbed by man. In the Mai Pokhari area mean annual precipitation is 1368 mm, most of which falls in June and July. Snow fields often persist in the upper hills in January. The maximum and minimum temperatures in winter (January) were 15.6°C and 9.6°C, and in summer (July) 26.8°C and 18.7°C.

## MATERIAL AND METHODS

The Himalayan Newt is well distributed in various localities of eastern Nepal. It is found in abundance during May and June soon after sustained monsoon rain. It breeds in rock pools where aquatic vegetation grows in profusion. Breeding starts during early May and lasts for about two weeks. During the breeding season male and female newts come to deposit eggs in rock pools. 40 to 90 eggs are laid by the individual newt. Eggs are spherical and demersal. They are usually attached to pond weeds, particularly *Polygonum.*

Samples of fertilized eggs were drawn from the pond bottom and transferred to an aquarium containing pond water and weeds. The morphological changes in the fertilized egg and embryo were sketched and for detailed study they were scanned under a stereoscopic microscope. For the detailed study batches of eggs were removed every hour and treated with 5% acetic acid. After treatment with acid, the egg membrane became quite clear and facilitated proper sketching.

The early tadpoles were reared in pond water and fed with zooplankton and phytoplankton from natural ponds. The fully grown larvae were transported to Kathmandu and fed yolk of eggs. I examined 2000 eggs and 200 larvae from the study areas, at various stages of their development. Their morphological changes were noted *in situ.* Snout to vent length (SVL) was measured with dial callipers. All other measurements, including egg diameter, were made with a dissecting microscope fitted with an ocular micrometer.

Early and transformed larvae were collected from the study areas. The larval newts were abundant in shallow pools. They were often found attached to vegetation. Maturity of the newt larvae was confirmed in the case of males by microscopic check for spermatozoa in seminal fluid from vasa differentia. All females were checked for the presence of gravid eggs.

**Sexual dimorphism:** *Tylototriton verrucosus* does not show sexual dimorphism, but the female can be easily recognized during the breeding season by its highly distended belly. The male expels milt if the abdomen of the animal is pressed hard in the breeding period.

**Courtship:** Himlayan Newts enter the rain pools with the first rains during early spring (March and April). They perform an elaborate courtship display. No distinct courtship call except the low *twak, twak, twak* was noted. The male exhibits orange coloured underparts especially in the caudal region to attract the female. Many females congregate near the courting male. The male selects a willing female and clasps her from below, i.e. vent to vent. He holds her tightly with his forelegs for about one hour. Most pairings take place at night. As a result of the pressure of clasping, the anal opening of the female is projected. Soon after, ripe eggs ooze out gradually and remain attached to the vent of the female due to their sticky nature. At this time male release spermatophores or sperms and fertilizes every batches of freshly laid eggs. Some of the spermatophores that are released by the male are sucked up by the female's cloaca later and await internal fertilization. The pairing newts move from one aquatic plant bed to another and thus allow the sticky eggs to attach themselves firmly onto leaf, stem or root. Some of the pairing females get exhausted by repeated clasping of males and die due to internal haemorrhage, while others suffer from ventilation in muddy water and die due to respiratory failure.

**Age at maturity:** The male *Tylototriton verrucosus* attains maturity when it reaches 150 to 200 mm in length. The female reaches maturity when it reaches 120 to 180 mm length. The Himalayan Newt becomes sexually mature and reaches the above size at the age of two years. No evidence of neoteny was detected in 100 salamander larvae reared in captivity. In nature also no such evidence was found.

**Clutch size:** More than fifty females from the various areas mentioned above were examined. The total number of oviducal eggs varied from 30 to 60. The average clutch size was 40. The intraovarian egg measured 6–8 mm in diameter. Nearly all mature intraovarian eggs showed early developmental stages which provided indirect evidence that the spermatophores enter the cloaca of the female and fertilization takes place internally.

**The egg:** (Plate 2) The egg is transparent, round in shape and is enveloped by an outer layer of loose jelly and an inner layer of fluid. Eggs are laid in groups, and remain attached to the leaves of submerged plants, particularly *Polygonum* spp. Developing eggs are interspersed with soil particles and bottom debris. The freshly laid large eggs measure 10 to 15 mm in diameter. The diameter of internal eggs ranges from 8 to 12 mm. The thickness of the egg envelope ranges from 2.0 to 2.5 mm.

**Cleavage:** About eight hours after fertilization, a crecentric, narrow blastodisc appears over the yolk mass. The first cleavage occurs one hour after fertilization. The second cleavage follows after 18 hours. A few hours later a third cleavage starts. After 2 hours the egg reaches the 8–celled stage. The fourth cleavage occurs after 40 hours of fertilization, and as a result a 32–celled embryo is formed. The developing germinal disc is held in the centre and the whole mass appears loose, pale yellowish and finally gets transformed into an irregular mass.

**Differentiation of embryo:** (Plate 2) The blastoderm cells gradually spread over the yolk mass. The yolk plug stage is reached at about 48 hours. The yolk is now completely invaginated by blastoderm cells in the next 72 hours and embryonic rudiments are formed as marginal, narrow and thick bands. The elongation of the embryo starts when it is 72 hours old. The blastosphere is formed, which measures about 1.2 x 1.5 mm. In 92 hours the cephalic and caudal regions become clearly discernible. At this stage the notochord is differentiated. Over the next 144 hours all components of cephalic caudal ends become differentiated and are easily distinguishable from one another. The three pairs of gills appear in this stage.

The cephalic region becomes more prominent when embryo is eight days (192 hours) old. At this time the rudiments of the optic vesicle is formed. Now the embryo has 8 to 12 well differentiated mytomes. At about 200 hours a pair of balancers is formed. And after 264 hours gills appear and the heart is formed. Pulsation of the heart starts at this stage. In 316 hours rarification of branchiae starts and the pro-larva is fully formed.

**Vulnerable stage during embryonic period:** *Tylototriton verrucosus* embryos hatch long before the yolk is used and feeding becomes necessary. The time of hatching was influenced considerably by the amount of mechanical disturbance to the egg. It seems to make little difference to the embryo whether it is within or outside the egg membrane. The advantage of early hatching or hatching at pre-feeding stage may be that it allows dispersal from the nest site to escape desiccation or predation. Mortality is high during the embryonic stage due to domestic pollution. Detergents and agricultural pesticides washed from rice fields by rain cause considerable mortality of developing eggs.

**Early larva:** (Plate 2) An early larva of *T. verrucosus* measures about 6 mm to 10 mm in total length. The body of the larva appears to be rounded owing to the large amount of the yolk contained in the belly. At this stage the larval newt closely resembles the sac–fry larva of a fish. The larva is now small, round and semi—transparent, with large eyes. The eyes are covered with a skin fold and eyeballs are quite distinct. There are three external gills on each side of the head, which are set in graduated series from above downwards. The mouth is relatively large and transverse and open externally. The anus is still imperforate. The abdomen is creamy white in colour but the dorsum and tail are brownish black and usually shot with melanophores. The larva shows interesting twisting movements inside the egg capsule. It soon breaks its transparent double layered envelope and becomes free to feed and grow. This usually happens during the last week of July or in the first week of August.

**Free swimming tadpole larva:** (Plate 2) The early, free swimming larva of *T. verrucosus* has an elongated body with well developed external gills. It has pairs of "balancers", which originate from a point behind the eye. The tail is lanceolate and gradually shows a crested appearance. The limbs are rudimentary. At this stage the larva shows a photonegative response. It measures 5 to 40 mm in total length. Free swimming larvae occur in great abundance from early August to the last week of September.

**Advanced tadpole larva:** (Plate 2) The free swimming tadpole larva of *T. verrucosus* gets metamorphosed into advanced tadpole larva at the end of October. The advanced larva is characterised by well developed limbs. The limbs and digits are quite complete. The so called balancer of early stage disappears completely at this stage, although vestiges remain in the form of small tubercles at the point of their origin. At this stage, larvae show photonegative and geopositive response.

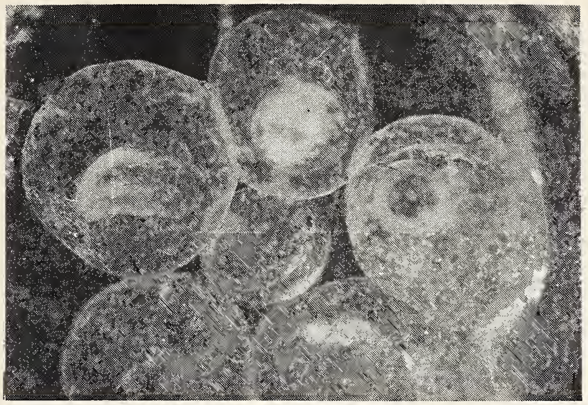
The advanced tadpole larva is yellowish brown, with splashes of black and white on the side of the body and back. The abdomen is whitish. The head is longer than broad; eyes are almost entirely lateral. The tail is well developed with an obtusely pointed tip and upper and lower crest. On the back or dorsum of the larva there is a distinct dorsal crest which disappears at the neck region. Further, a prominent ridge appears at the side of the head as the larva matures further. The opercular folds and gill lamellae are still developing. Finally, knob–like projections appear on the lateral sides of the body adjacent to the plicated skin fold, which develop into tubercular glands. The mouth becomes wide and vomerine teeth appear. Larvae feed actively on animal and vegetable matter found in rock pools.

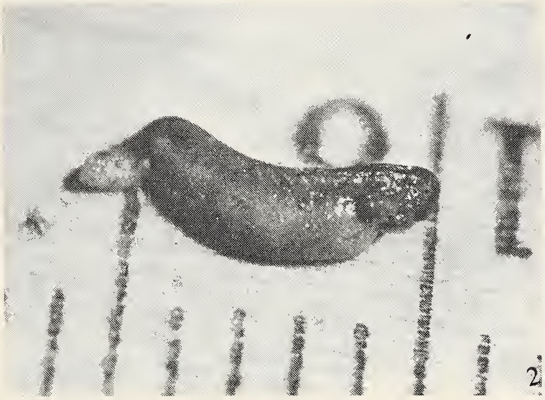
The newt larva at this stage measures 250 to 550 mm. The majority of larvae surface frequently to gulp atmospheric air. Some of them are also seen breathing atmospheric air directly by extending nostrils out of the water.

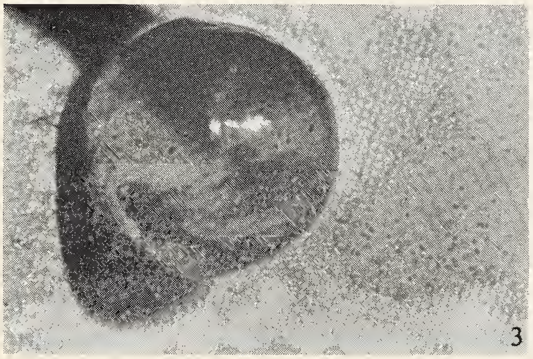
**Young newt at critical stage:** (Plate 2) A fully metamorphosed juvenile newt shows some distinctive changes. One such change is the absorption of the dorsal crest. The absorption points are indicated by scars. Another notable change is the total absorption of gills. Aquatic respiration is now replaced by lung respiration. In this transitory or critical stage between aerial and aquatic respiration, mass mortality of larvae is noticed. The examination of dead larvae shows inflammation in gills, gular pouch as well as in the lungs. The sequence of morphological changes occurring in juvenile newts is as follows:

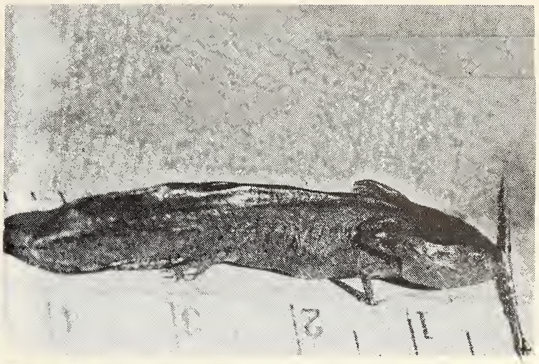
1. Body colour of the larva changes from yellowish brown to pitch black.
2. Head becomes triangular and V shaped and ridges appear on its sides.
3. Opercular folds become fully absorbed.
4. Eyes become prominent and project outwards.
5. Skin texture appears more granular, original slimy character is lost.
6. Gills shrivel off completely;their vestigesare indicated by scars.
7. Young newts become photonegative and geopositive.
8. Newts seek shelter in moist places and show a tendency to hibernate.

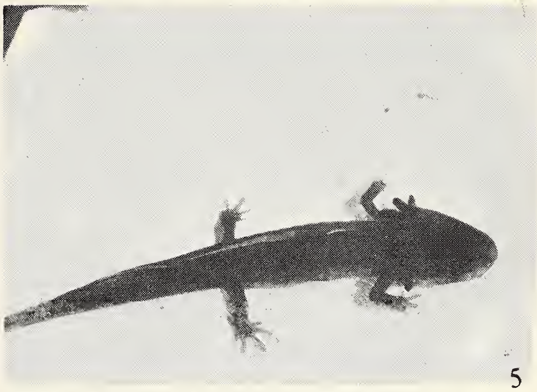
Juvenile newts leave water after the absorption of gills, and start a terrestrial life. They seek wet



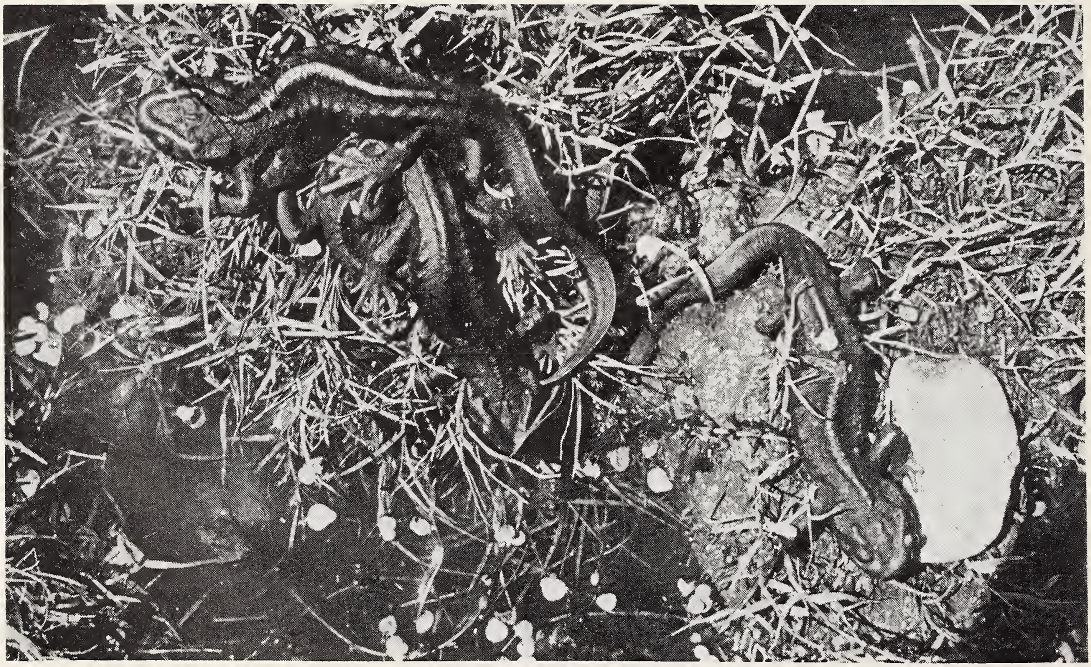








1. Himalayan newt eggs showing different stages of development. Note fertilized egg with large nucleus, early spindle shaped embryo and advanced fish like embryo. 2. Embryo as seen after removing the jelly like egg envelope. This is the 92 hrs embryo with distinct cephalic and caudal regions. 3. An embryo with well formed gill. At this stage the embryo rotates on its axis and makes jerky movements. 4. Larva of newt with fully developed gill. 5. Larva of newt with stumpy gill. As the pond dries up the gills get slowly absorbed and shrivel off. 6. Newt larva with gills fully absorbed. The young newt scrambles over the edge of the pond and seeks shelter in moist crevices to tide over the icy winter.



*Above*: A typical rainwater rock pool in far eastern Nepal (Ilam)
*Below*: Adult newts about to enter the breeding pool for depositing eggs and spermatophores.

and shady places for shelter. If such places are not available, they hide themselves among leaf litter and rock crevices. The growth of the juvenile newt is quite slow throughout the winter. They are not seen feeding actively during this period. At places where lakes and rock pools freeze in winter, young newt larvae with or without gills are seen swimming beneath the layer of ice. Various coloured paints were used to mark juvenile newts. The marking showed that young newts migrate from 0.5 to 1 km per day. High mortality is noticed at the time when newts abandon rock pools. This takes place generally during the dry period (December to March). The water to land migration is an important phase in the life history. About 40% of juvenile newts die off in this stage. The larval period in the Himalayan Newt lasts about 10–14 months. Study of the water requirements of the juvenile newt in the land phase is necessary for the conservation and management of the species.

**Adult newt:** When the juvenile newt metamorphoses into the adult form, changes in head shape take place. The widest point of the head lies at the back of the eyes, where it appears slightly swollen. Beyond this point the head converges to lateral extension of the gular pouch to a point, making a fairly pointed snout. The eyes are protruberant and their posterior angle is limited by a short vertical fold. Gradually, gular folds show greater development, which is marked by deep sinuous grooves running from posterior angle of eye to lateral extension of gular folds. The dorsal crest totally disapears in this stage. Lateral tubercles become more prominent, which vary from 14 to 16. The tail becomes long and flattened ventrally. The shape of the tongue also changes from spherical to oval and its margin becomes thin and smooth. The vomerine teeth also appear behind the nares and curve inwards towards the middle of the line. The parasphenoid teeth become slender and club–shaped.

## Discussion

The general categories of the life histories are described in salamander species (Dunn 1923, Salthe 1969). Mode I describes species with numerous small eggs which are deposited unprotected in lentic waters, e.g. *Ambystoma, Trachia.* Mode II characterises the species with fewer, larger eggs deposited in hidden nest sites in lotic waters and often guarded or attended by one of the parents, usually the female, e.g. *Decamptodon.* Mode III describes species with well hidden terrestrial nest sites (larval stage is compressed into embryonic stage) and almost invariably attended by the female parent, e.g. *Plethodotines. Tylototriton verrucosus* belongs to the Mode II category, although it appears that parental care is not a part of the life history. In this respect it closely resembles the Olympic Salamander *Rhycotriton olympicus* (Nussbaum 1969).

Ferrier (1974) described embryonic development of *T. verrucosus* in his laboratory. According to him the newt completes its embryonic development in 110 hours after fertilization. The present investigator records the fact that embroynic development in the wild state takes longer (240 hours) than was previously believed. In the wild state temperatures fluctuate widely from 12° to 24°C; the newts hence take more time to develop.

Little is known about mating in *T. verrucosus.* It appears that females frequently mate more than once in a breeding season. The examination of the ovary of breeding females show both developed and developing eggs. The fully developed eggs are fertilized and released in the first mating and developing eggs are used as a reservoir for a second or third mating. In this respect *T. verrucosus* resembles *Ensatina eschscholtzi* (Stebbins 1954).

I estimated that larval periods for newts living in eastern Nepal were 10 to 14 months. This period is comparatively shorter than for *R. olympicus* (Nussbaum and Tait 1977; 24–48 months) and *Decamptodon ensatus* (Nussbaum and Clothier 18 months). I detected a migratory tendency in juvenile newts whose gills were fully absorbed. Many of them were seen climbing over the edge of rock pools and breathing through the lungs. Some young newts were seen in an inactive stage in the pool. A number of stream dwelling newts exhibit the phenomenon of sight tenacity as described by Nussbaum and Tait (1977). No such sight tenacity was witnessed in rock pool adapted *T. verrucosus*.

### CONSERVATION AND MANAGEMENT

Expanding human population and ensuing habitat destruction have contributed to the endangering of the newt in Nepal. All stages of the life history of Himalayan newts are especially vulnerable to pollution because most spend at least part of their lives in water. One widespread form of water pollution is the use of detergents and pesticides. The eggs and larvae of newts will die if acid levels are too high. Many newts breed in small rock pools that result from spring rains and melting snow. These pools tend to be especially acidic because humic acid has been accumulating over winter with each snow fall. Although insignificant when compared to habitat destruction and pollution, exploitation for folk medicine is another threat. The larvae of the newt also suffer from depredation by collectors, who use lift nets to capture large numbers to sell them to witch doctors. We can help ensure the survival of newts by demanding strong legislation in support of anti–pollution regulations, habitat preservation, protection endangered species and more stringent control over the wildlife trade. Considering all these factors, there is an urgent need to establish Himalayan newt sanctuary in highland Nepal before the species becomes extinct.

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# THE GREENBILLED OR CEYLON COUCAL *CENTROPUS CHLORORHYNCHUS* BLYTH — SRI LANKA'S RAREST ENDEMIC SPECIES[1]

THILO HOFFMANN[2]

Observations are made on a pair of Ceylon Coucals and a call hitherto not recorded is described. This endemic species is endangered.

On 29 January 1988, Ben King of the American Museum of Natural History, together with James and Robert Clements, observed a Greenbilled Coucal *Centropus chlororhynchus* at Kitulgala, where the species is known to exist. At that time the coucals were calling very early in the morning between 0600 and 0630 hrs, and Ben King managed to record on tape a call which had hitherto not been described, and which consists of a series of double notes, *hoo, hoo–hoo, hoo* ('oo' short), two *hoo*'s in quick succession, then a pause, followed by another two *hoo*'s, which may be repeated twice or thrice, occasionally four times. The sound is rather gentle and by no means loud, though it carries far and can clearly be discerned amongst the much louder calls of the Brownheaded Barbet *Megalaima zeylanica* and Yellowfronted Barbet *Megalaima flavifrons* in a general babble of early morning bird song. When Ben King gave me a copy of the tape, I decided to try my luck and visited the area on 13 February 1988.

With my wife and a friend I arrived at Kitulgala from Colombo shortly after 0500 hrs, and had to wait till 0600 before daylight broke, and another half hour before the ferryman from across the river bothered to come with his outrigger dugout to pick up the waiting passengers, of whom there were quite a few. Just before 0600 hrs, when it was still dark (the sky was overcast), I heard the Common Coucal *C. sinensis* from across the river and also what I thought was the same call Ben King had recorded, but only briefly and not again. In recent years birdwatchers have reported seeing and hearing Greenbilled Coucals in several low-country wet zone locations (Labugama, Sinharaja, Kitulgala) and most refer to the deep, booming call. I think Henry (1955, p.182) renders it fairly well as *hooo-poop, hooo-poo-poo*, the *poop* being lower pitched than the *hooo*, but those who have not actually heard it may be unable to mentally transfer the written letters into sound, interpreting the treble and double o's in Henry's description as long-drawn out booming sounds, whereas King's taped call consists of a short double syllable which might be better transliterated as *hu, hu* ('hu' as in book). Contrary to what Henry writes, the two syllables recorded by King are identical and at the same pitch. According to Legge (1880) the call is a "long-drawn *hoo-whoop, whooop*". Compare with the Common Coucal: *hooop, hooop, hooop,* (Legge) and *hoop oop oop oop oop* (Henry). I fear that the call of the Common is often mistaken for that of the Greenbilled.

When we reached the opposite bank it was already well past 0630 hrs, and we went towards the bottom of the valley through which runs from the south a tributary of the Kelani Ganga, just opposite the Kitulgala Resthouse. The area consists of densely covered village gardens with scattered houses and several paths, Coconut and Areca palms (*Areca catechu*), Jak trees (*Artocarpus integra*), Avari-nuga (*Alstonia macrophylla*), Sapu (*Michelia champaca*), and other planted timber and fruit trees, groves of betel, yams, coffee, and an occasional tiny paddy field as well as ornamental shrubs and trees. Despite being inhabited, this small area is thickly covered with trees and vegetation. Due to the annual drought at the time of the visit, the ground was parched and with without herbage; many trees and shrubs were

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shedding leaves. Near the last house on the path to the valley, we observed a Coucal fleetingly in a king coconut tree, from where it slunk down into some coffee bushes. We waited and played Ben King's recording. Nothing happened, but after a while a Common Coucal hopped out of the coffee into the open under some coconut palms. It was absolutely silent, hopping and strutting along the open ground. It did not react in any way to the taped call of the Greenbilled Coucal. We moved further in the direction of the tributary, separated, waited and watched.

I went down to the nearly dry riverbed with many boulders and nice natural vegetation on either bank. Suddenly a coucal flew from one bank to the other, and it was indeed the Greenbilled, the bill being very clearly visible to the naked eye at a distance of 7 to 10 m. The massive bill of the bird is ivory coloured and very eye-catching. The bird flew into a *Lagerstroemia* tree on the other bank which was heavily overgrown with the thorny creeper *Hinguru-wel* (*Acacia* sp.). It stayed there, partly hidden from view with the bill rarely visible; from time to time it moved stealthily from branch to branch in various directions. After a while a second bird of the same species flew across the river into the same tree and both then moved about or sat in the thicket, no more than 10 m away from where we were in the riverbed. The flight is a flapping, gliding progression.

From then on we watched the two birds for a full 2 1/2 hours (and could have gone on, undoubtedly). As we played the tape, the birds would cross and re-cross the river as if trying to pinpoint the exact location of the sound. As time went by they came closer and closer and sometimes sat in the branches right above us. The birds very noticeably reacted to the call recorded by Ben King. Whenever it was played they turned their heads as if listening, or began moving. The immediate reaction to the sound could very clearly be seen. Occasionally the birds would come out of cover and become fully exposed to view on the hanging stems of the *Hinguru-wel* creeper or in an opening of the leaf canopy. We could observe at length every feather and every feature of the two birds.

The most spectacular part is, of course, the bill, ivory coloured, as already mentioned, somewhat off-white, with a barely perceptible tinge of green or greenish. We watched the birds with the naked eye and through excellent binoculars. The massive looking bill is relatively larger than that of the Common Coucal. It is also more acutely down-curved and more pointed, even more than shown in Henry's black and white sketch (p. 182). This might indicate that the Greenbilled Coucal is more specialized on particular sources of food (perhaps snails) than its common cousin. Throughout the 2 1/2 hours that we observed the birds, they never fed and not once came down to the ground or near the ground, always moving within trees and thickets, say 3 m or more above ground. The breast of the Greenbilled Coucal shows individual feathers or groups of feathers in a sculptured manner and the sheen on the breast and throat, especially the sides of the breast, is purplish. The chestnut of the wings is darker than in the Common Coucal.

The description light green or pale apple green as generally applied to the colour of the bill in the literature is in my view quite misleading, and so is the name by which the bird is commonly known in Sri Lanka (Henry). Ali and Ripley call it the Ceylon Coucal, and so do Wait and Fleming, which seems more appropriate than Greenbilled. Legge called it the Ceylonese Coucal. One could well name it the Ivorybilled Coucal or the Palebilled. Birdwatchers who have never seen this coucal look for an apple green bill, and it has happened that the Common Coucal carrying a mantis or a grasshopper in its beak was mistaken for the endemic species. The illustration of the beak by John Henry Dick in Ali and Ripley's PICTORIAL GUIDE (1983)is far too green, and its shape and size are not quite right either. The illustration in Legge is superb, though the bill is also rather too green. It is possible that in the hand (or in dead specimens) the greenish tinge is more noticeable than in the field.

During the entire period of observation we never heard the *hoo, hoo* call of the tape, but after about an hour, when both birds were in the same tree right opposite us, one of them gave off a series of gentle, low, single-syllable *hoo*'s which sounded like the call of the Ceylon Fish Owl *Ketupa zeylonensis*, soft but sonorous, best emulated with closed lips, with rather long spacings between each call. The bird dipped its head with each syllable, the sound being produced with the beak shut. Thereafter we heard this same gentle, mournful, mono-syllabic call a number of times on either side of the river. It would appear to be a communicating call between the pair. We did not hear any other notes like Henry's *chewkk* (courting) or Legge's loud *dhjoonk* (alarm).

The range of this pair of Greenbilled Coucals seems pretty small and restricted, and it appears to overlap with the range of one or several Common Coucals. Judging from the non-reaction of the Common Coucal to the taped call of the Greenbilled, the two species do not seem to interact in any way and may have their separate niches for food, roosting and nesting in a shared general habitat. Henry says that pairs of the Common Coucal, which appear to mate for life, are very jealous of any encroachment of their territory by other coucals, which does not appear to apply to the other species; no Common Coucal turned up during our observation. It would seem that the Greenbilled Coucal is less terrestrial than its common cousin, as we did not see it on the ground, whereas the Common spends a lot of time on the ground.

Interestingly there is no bamboo anywhere in this particular habitat, and Fleming's speculation that bamboo is an indispensable critical element for the survival of this rare bird may not be tenable. Except for a narrow strip on either side of the river, the vegetation is mostly man-made or strongly man- influenced. It is not at all the climax-type, undisturbed rain forest presumed essential for the Greenbilled Coucal, but a mixture of typical wet zone village gardens with their high and low tree and bush cover (Coffee, Coconut, Areca), weeds, and patches of uncultivated land. There is forest not far away up the valley, rain forest which has been heavily logged some years ago and in which are present a number of typical wet zone forest birds, including many of the endemics. This forest does contain some bamboo (*Bata*) as undergrowth, but the Greenbilled Coucal has not been noted so far in this natural (though logged) forest, where the Ceylon Magpie *Cissa ornata* nests, where the White-headed Starling *Sturnus senex*, the Redfaced Malkoha *Phaenicophaeus pyrrhocephalus* and the endemic babblers are found.

So far the Greenbilled Coucal has only been observed in the village area at the bottom of the valley, in close proximity to human habitations and much human goings on, with gardens and cultivations, though all well covered with trees and shrubs. Kitulgala, 100 km east of Colombo, lies in a deep, rather narrow valley at the foot of the central mountain massif near where the various streams which form the Kelani Ganga, one of the country's major rivers, join together after their descent from the hills. The elevation is about 65 m above m.s.l. Just east of Kitulgala the mountains begin to rise steeply. The place is embedded in forest or plantation covered hills (rubber and tea). It lies in the area of the highest rainfall in Sri Lanka, around 5000 mm average per annum. The natural forest is tropical rain forest. There is a dry period in January/February each year, otherwise precipitation is heavy throughout, with high temperatures and high humidity.

According to Henry the breeding season of the Greenbilled Coucal appears to be the first half of the year (Legge: Probably April or May to July). The domed nest, which is placed in thorny bushes (e.g. *Hinguru-wel*) 1 to 1.5 m from the ground, has rarely been found. If the bird was calling (''singing'', according to Ben King) intensively at the end of January when Ben King heard and taped it, and is now silent 2 weeks later, it might be that the courting season is over and nesting might have started. We saw no evidence of nest-building or any activity connected with breeding, though the two birds obviously were a pair. Ben King saw only one bird. Greenbilled Coucals were heard callling on 27 December 1989 in the Morapitiya Forest Reserve (P.B. Karunaratne, pers. comm.) and on 26 January 1989 at Sinharaja (Dr P. Samaraweera, pers. comm.), both times in the early afternoon (CBCN).

The Greenbilled Coucal is almost certainly the rarest of the Sri Lankan endemics, and thus one of the rarest birds in the world. Only a few people have recently seen it and then only fleetingly. Even in Legge's time, over 100 years ago, this coucal was supposed to be very rare, probably because of its wary and secretive habits, but Legge found it in considerable numbers throughout a large tract of the wet zone low-country from about the Deduru Oya in the north right along the bottom of the hills to Galle, and the coffee districts of the Morawak Korale; he found it numerous in the Ratnapura District and up into the Peak Wilderness forests to about 800 m. He traced it mostly by its call and says that it is seldom seen and "almost defies all discovery". In the meantime the country in which the coucal was common according to Legge has been developed to an almost unimaginable extent and is the most densely inhabited part of the Sri Lanka. Very few natural jungles remain in the form of forest reserves (including the Sinharaja MAB reserve), and the Peak Wilderness Sanctuary. Henry (1955) says about the Greenbilled Coucal: "Its range is rapidly dwindling and as it shows no sign of being able to adjust itself to new conditions, there can be no doubt that its days will soon be numbered–with those of several other endemic birds–unless wise foresight reserves extensive forest sanctuaries in the wet zone". So far very little "wise foresight" has prevailed, with most forest reserves dwindling from year to year, the only exception being parts of Sinharaja.

The question now arises as to what can be done to ensure the survival of this rare, attractive and probably highly specialized bird, which is unique to Sri Lanka and which today may be present in only a few hundred pairs in the locations from which it is known. An obvious place for the protection of its environment would be the Kitulgala site just described. Apart from the nearby forest reserve, the actual habitat of the birds (and I hope and assume that there is more than one pair in the wider area) is private land. A few pairs may be secure in the small Labugama Reservoir area (drinking water for Colombo), access to which has, however, been denied to ornithologists for a number of years, ever since the National Water Supply and Drainage Board made it almost impossible for genuine researchers and observers to go there; it is now out of bounds for security reasons. On the other hand this very Labugama area is vulnerable to incursions, illicit felling and poaching from nearby villages. Other areas where the Greenbilled Coucal has been occasionally observed in recent years are Sinharaja, notably the course of the Koskulana Ganga near Kudawe which forms part of the northern boundary of the reserve, and the Runakanda-Morapitiya Forest Reserve to the west of Sinharaja. Some of the forest reserves in the south, such as Kottawa and Kanneliya, should also harbour small populations of this coucal. In all these cases the habitat is disturbed rain forest. These are the only places that I know of where in recent decades the Greenbilled Coucal has been seen or heard, and nowhere can it be plentiful.

The best hope for the Greenbilled Coucal may be the lower edge of the Peak Wilderness Sanctuary, as already suggested by Fleming. I recently visited a section of this forest above Deraniyagala-Maliboda at an elevation of between 450 and 800 m. There is thick bamboo undergrowth in nearly undisturbed forest; I heard a coucal at around noon, but am not sure which. The tape playing did not help, and a long-time resident told me that he had never heard the taped call. As Legge found the bird numerous in the Ratnapura District, it should still be found in the Gilimale forest, for instance, where conditions for its existence appear to be excellent, with good forest and fine undergrowth, including bamboo; the same can be said of the forests and village gardens around and above Alupola, Hapugastenne, Carney, and Eratne, along the southern boundary of the Peak Wilderness Sanctuary, between 450 and 650 m, which I visited recently without, however, finding a trace of the coucal.

It is high time that the survival of all of Sri

Lanka's endemic birds should be purposefully planned and the necessary habitat reserves fully protected. For the last several years I have urged that the Peak Wilderness Sanctuary with some adjoining forest reserves should be upgraded into a National Park which would provide total habitat protection for all of Sri Lanka's unique birds and most of its endemic plants and animals.

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# FUNCTIONAL MORPHOLOGY OF THE POISON APPARATUS AND HISTOLOGY OF THE VENOM GLANDS OF THREE INDIAN SPIDERS[1]

RIDLING MARGARET WALLER[2] AND G.J. PHANUEL[3]

*(With three plates and seven text-figures)*

The morphology of the poison apparatus and the histology of the venom glands of three large Indian spiders, representing two major suborders, are described. Data pertaining to the morphometry of the poison apparatus of the three spiders are presented. Anatomically, the gland structure is fairly uniform consisting of two principal layers. However, differences were observed in the nature of the muscle layer and the venom secreting cells not only within the three species studied but also within the same species at different stages of their venom secretion.

## INTRODUCTION

As spiders are obligate suctorial carnivores the study of the mouth parts, particularly the venom injecting apparatus, has been a subject of great interest to morphologists and physiologists, as reviewed by Bristowe (1954).

As early as 1878, Lebert described the poison glands of spiders as salivary glands situated in the cephalothorax with a pair of ducts opening at the tip of the "mandibulae falciformes". Berland (1922) made a comparative study of the anatomy of the poison glands of spiders and suggested that the glands might be concerned with digestion. Millot (1931) studied the poison glands of spiders from several points of view and explained their relation to the large ganglionic mass in the cephalothorax as having a certain taxonomic value.

Since most research on venomous spiders has been conducted by scientists working in the Pacific area, in the present investigation an attempt has been made to study the poison apparatus, the nature of the venom-secreting cells and venom of some Indian spiders.

## MATERIALS AND METHODS

The specimens used in the present investigation were collected periodically within the 363 acre scrub jungle of the Madras Christian College and also from fields and deserted houses in the neighbouring villages on the outskirts of Madras. *Plesiophirctus collinus* Pocock 1899, the common funnel-web spider is a mygalomorph and *Heteropoda venatoria* Linn. 1766, the common house spider, and *Lycosa indagastrix* Walck 1837, the wolf-spider, are araneomorphs chosen for the present study.

Morphometric studies were carried out by measuring the different parts of the poison apparatus using a fine pointed divider and an ocular micrometer. The statistical methods employed in the study include correlation coefficient (r), Regression ($y = a + bx$, variation of $Y$ (sd$^2$), '$t$' regression, $F$. variance and $F$. regression.

For histological studies, live spiders were allowed to bite a cockroach until the chelicerae were completely inserted into the victim. The glands from such spiders and from those that were not fed were removed and fixed in 10% buffered formalin, sectioned at 5 to 8 m thickness and stained in Hematoxylin and Eosin for observations under the light microscope, to document the nature of the secretory products and the mode of secretion of venom.

## RESULTS AND DISCUSSION

**Venom apparatus:** The venom apparatus of spiders consists of a pair of chelicerae and a pair of venom glands. However, the position of the venom glands differs between the araeneomorphs

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or 'True spiders' and mygalomorphs or 'Tarantulas' as they are popularly known. Bertkau (1891) noticed differences in the size and site of the glands in several species of spiders, and described the compound gland of *Atypus*, the multilobular glands of *Filistata* and the bilobular glands of *Scytodes*. The position of the venom glands of the spiders studied are given in Fig. 1. In *P. collinus* the venom glands are situated dorsally in the basal article of the chelicerae, between the adductor and abductor muscles. The glands are carrot-like in form (Plate lc) with the broader end towards the base of the fang and the narrower posterior end inserted by an elastic fiber to the posterior border of the basal segment. This muscle fibre holds the gland firmly in its position.

The glands are white in colour, measuring about 3.5 mm to 4.0 mm in length, and about 0.8 to 1.0 mm in width, depending on the secretory state of the gland. In the true spiders *Heteropoda venatoria* and *Lycosa indagastrix*, the venom glands are situated in the cephalothorax with the adductor and abductor muscles holding them in position. The glands are sac-like or cylindrical and consist of two lobes (Plate 1a & b). Their length varies from 4.5 to 6.0 mm in *L. indagastrix* and are considerably smaller in *H. venatoria* measuring 3.0 to 4.0 mm.

The excreting canal is a long white tube. Its length in *P. collinus* corresponds to the length of the fangs, while in *Lycosa* and *Heteropoda* it corresponds to the length of both the articles of chelicerae. In true spiders the canal bears a spherical ampule at the junction of the fangs and the paturon. Its diameter varies from 0.35 mm to 0.45 mm in *L. indagastrix* and 0.10 to 0.15 mm in *H. venatoria*. Although the ampule is absent in the mygalomorph, the venom is ejected very efficiently, as the channel is short.

**Morphometry:** The following measurements were made to assess the growth rate of the poison apparatus in the spiders: length and width of

(1) the cephalothorax
(2) the paturon
(3) the fang
(4) the gland, and
(5) the duct.

It was observed that the determination of the growth rate of the venom apparatus and the comparison of the same in the three spiders based on allometric principle may reveal a better picture of the trend in the growth rate rather than the raw morphometric data. The allometric principle of growth, first proposed by Dubois (1897) explains the existence of a relation between the dimensions of various organs on the one hand and the dimension of a particular reference organ ($X$) on the other. The relationship is simplified by the formula $y = bx^a$. If $a>1$, it indicates that the rate of growth of a part is more than that of the reference organ; $a<1$ indicates a lower growth rate.

The data pertaining to the morphometric measurements of the poison apparatus in the three spiders are presented in Figures 2 to 7. In each figure pertaining to a particular dimension the following are indicated.

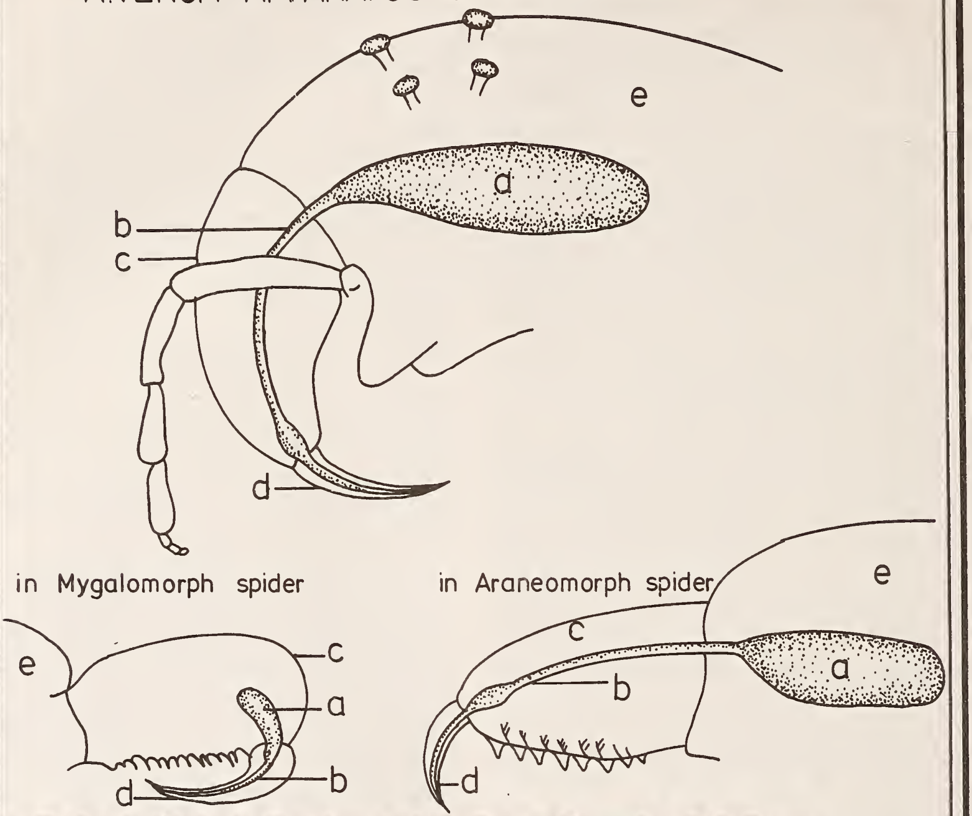
(1) The value of correlation co-efficient $r$

(2) regression coefficient and the significance of regression ($t$ regression) of the three spiders.

The correlation coefficient was found to be statistically significant at 0.001 in several characteristics. The measure of association between the two variables, i.e. cephalothorax length and gland length was significantly higher in *L. indagastrix* than in the other two spiders studied. The higher $b$ value further represents a faster growth rate. Since the glands are situated only in the paturon in *P. collinus*, but partly in the cephalothorax and paturon in *H. venatoria* and *L. indagastrix*, the degree of association of these characteristics with that of the total legnth of the gland and duct were analysed. A strong positive correlation was observed and hence they were subjected to regression analysis. The regression slopes reveal considerable significance between the cephalothorax length and gland length, paturon length and gland length, cephalothorax length and total length of the gland and duct, fang length and total length of the gland and duct in the two broad divisions of the order Aranea, the 'tarantulas' and 'true spiders'.

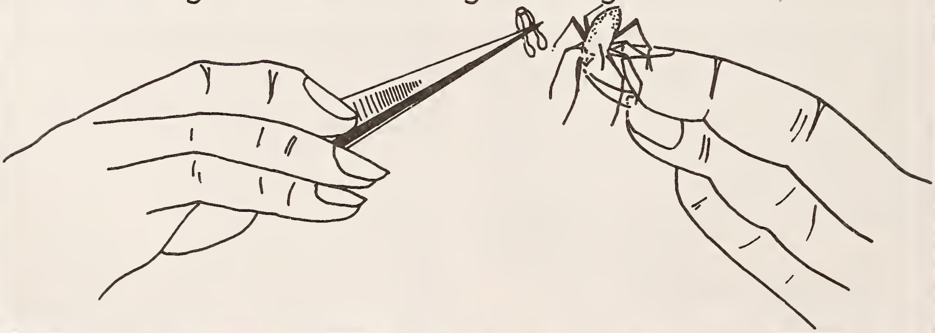
**Histology of the venom glands:**. Anatomically

A.VENOM APPARATUS OF A SPIDER


e
a
b
c
d
in Mygalomorph spider
in Araneomorph spider
e
c
a
b
d
e
c
a
b
d

a.gland b.duct C.paturon of chelicera d.unguis of chelicera
e.cephalothorax

Removing chelicera along with glands



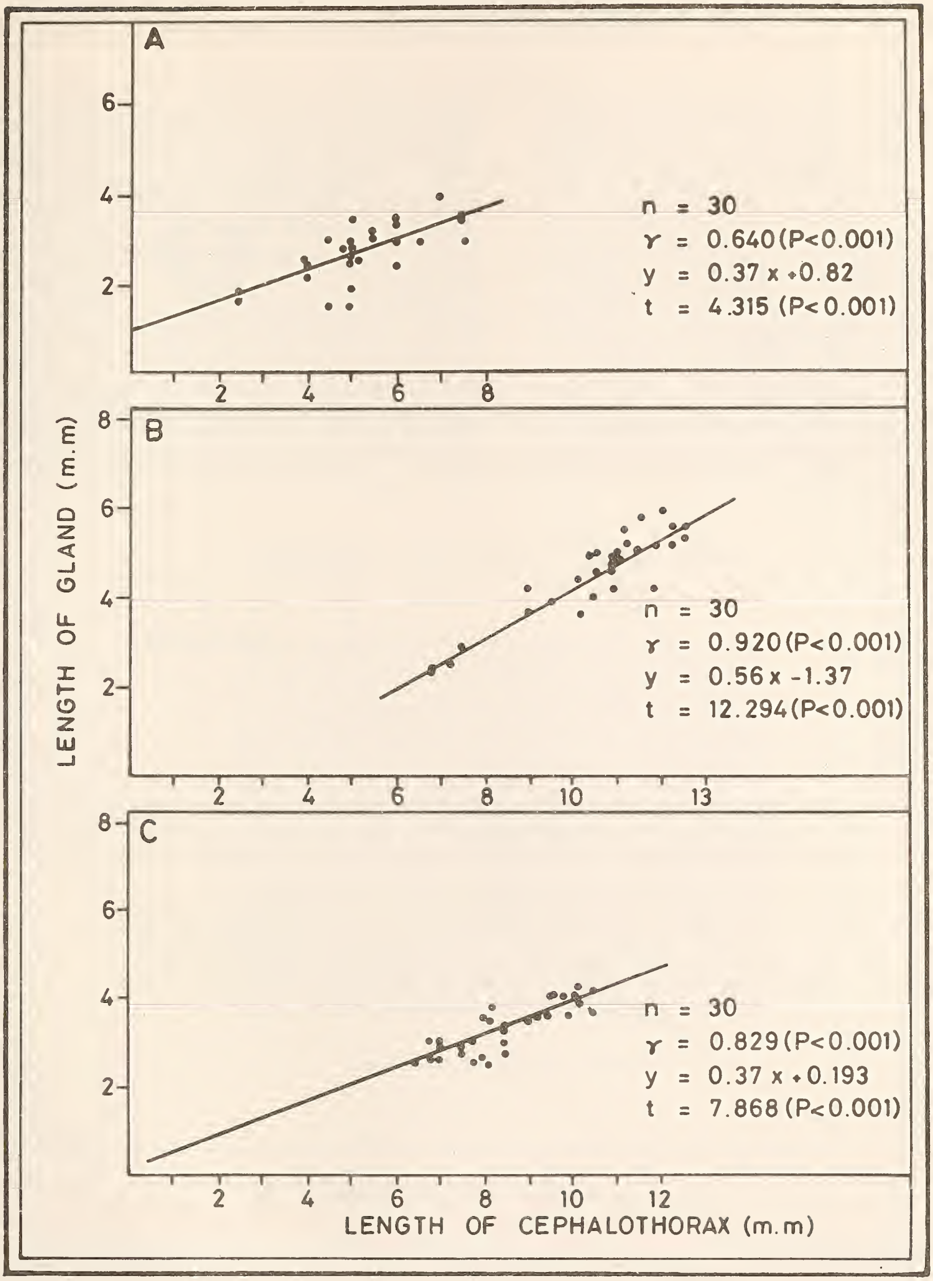


Fig. 2. Morphometric relationship of cephalothorax length to gland length for the three spiders: A: *Heteropoda venatoria*; B: *Lycosa indagastrix*; C: *Pleisiophirctus collinus*.

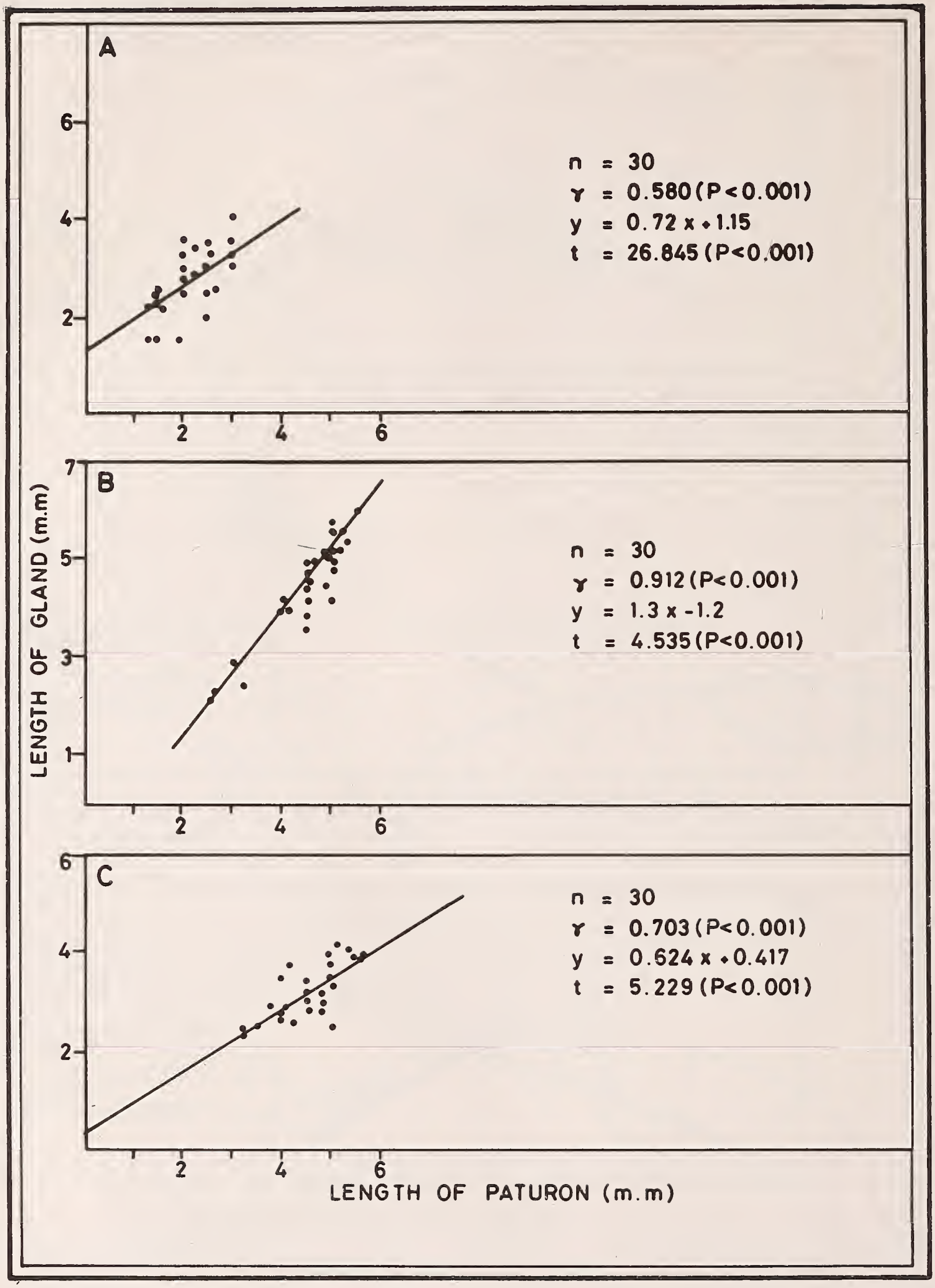
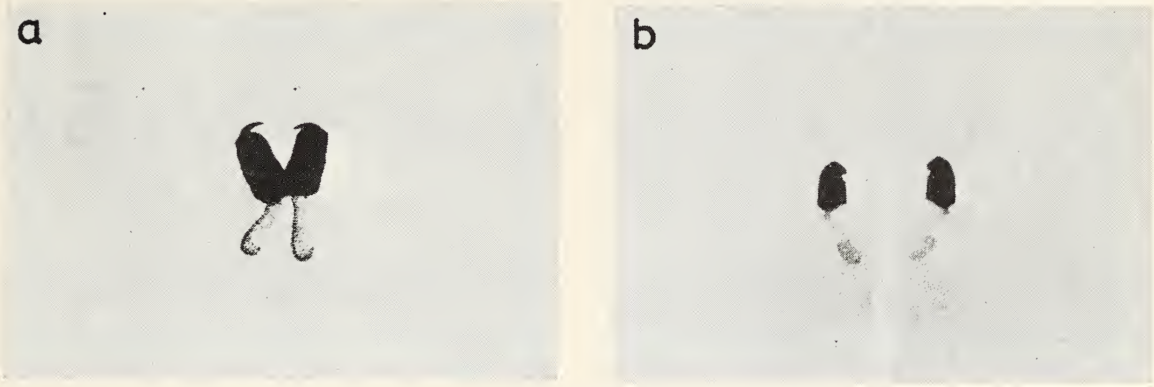
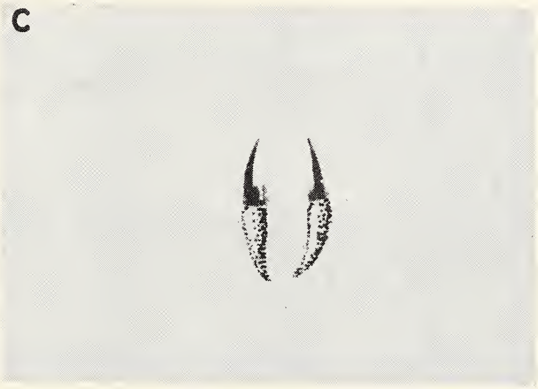


Fig. 3. Morphometric relationship of paturon length to gland length for the three spiders: A: *Heteropoda venatoria*; B: *Lycosa indagastrix*; C: *Pleisiophirctus collinus*.

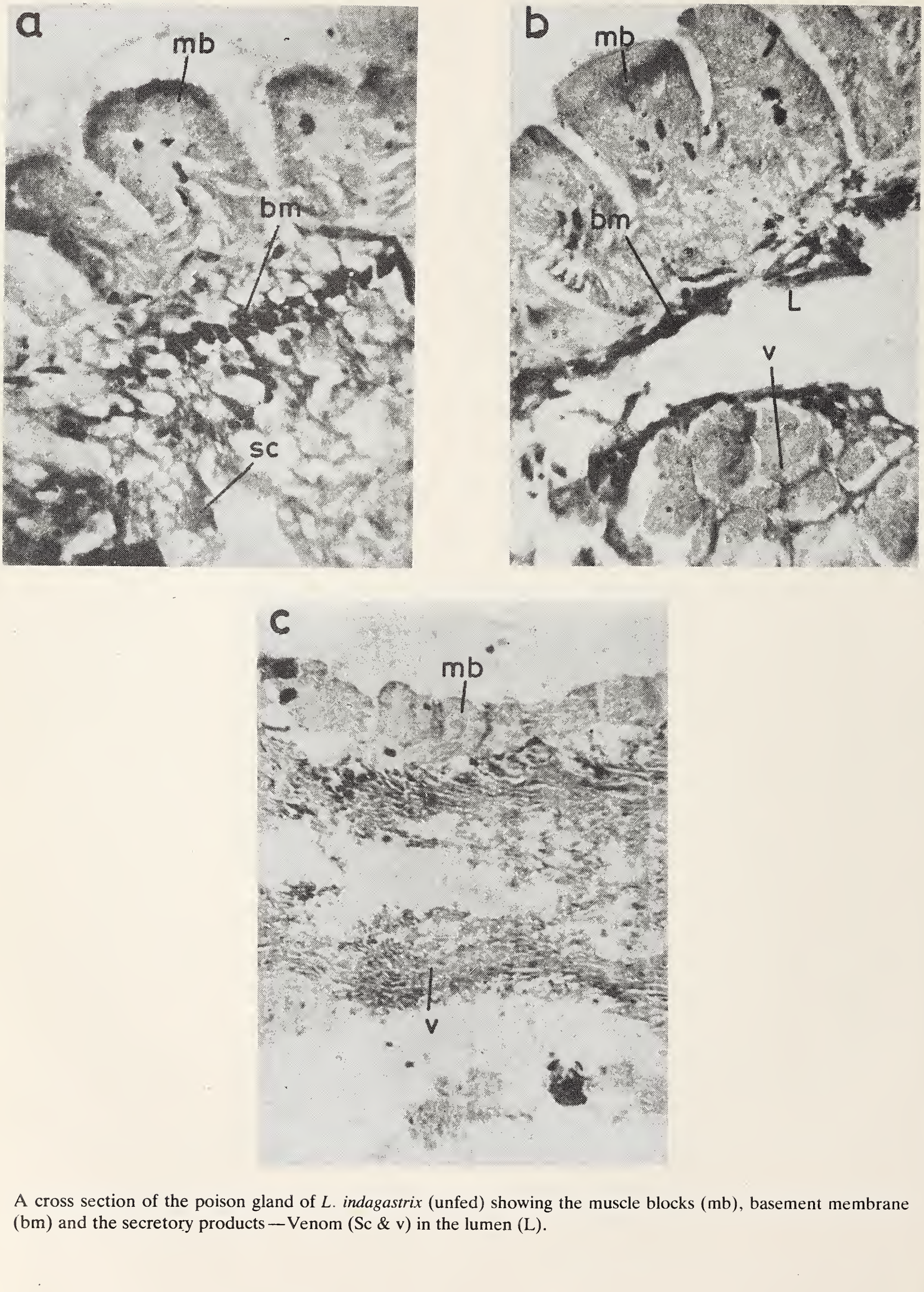
## Chelicerae and venom glands



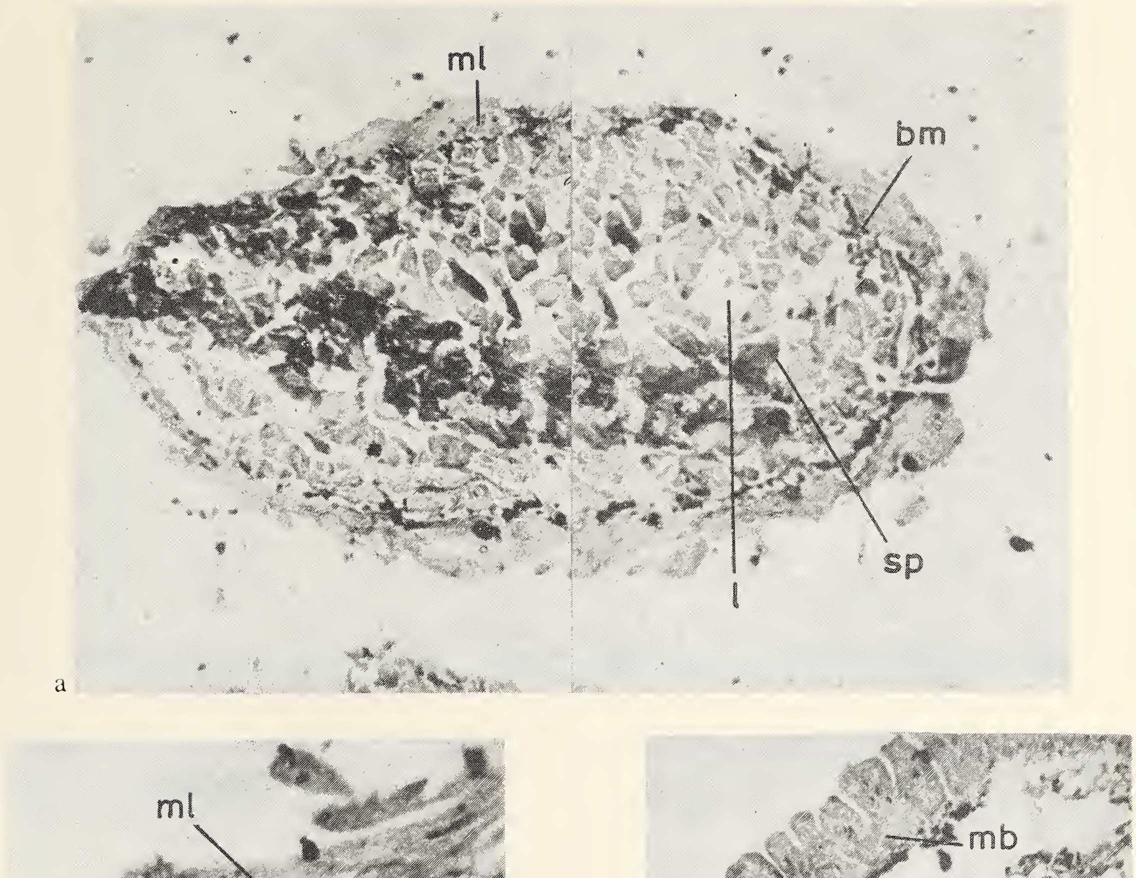
True spiders *L. indagastrix* (left), *H. venatoria* (right).



Mygalomorph spider *P. collinus*



A cross section of the poison gland of *L. indagastrix* (unfed) showing the muscle blocks (mb), basement membrane (bm) and the secretory products—Venom (Sc & v) in the lumen (L).



a, b: A cross section of the poison gland of *H. venatoria* (unfed) showing the retention of the secretory products (sp) in the lumen (1) of the gland and also the muscle layer (ml) and the basement membrane (bm).

c: A cross section of the poison gland of *P. collinus* showing the muscle blocks (mb), basement membrane (bm), the basement processes extending into the lumen of the gland and the secretory products (sp).

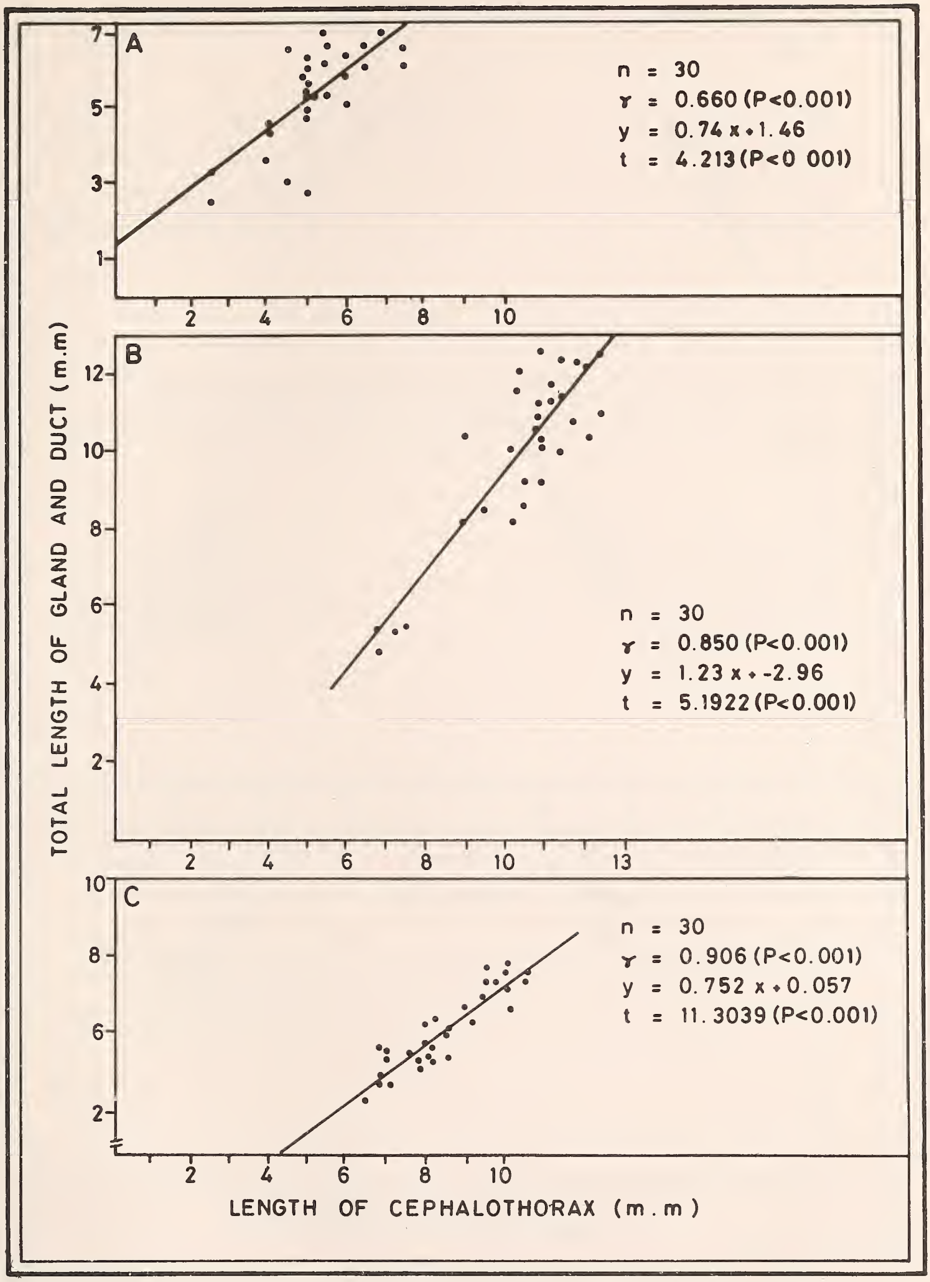


Fig. 4. Morphometric relationship of cephalothorax length to gland and duct length for the three spiders: A: *Heteropoda venatoria*; B: *Lycosa indagastrix*; C: *Pleisiophirctus collinus*.

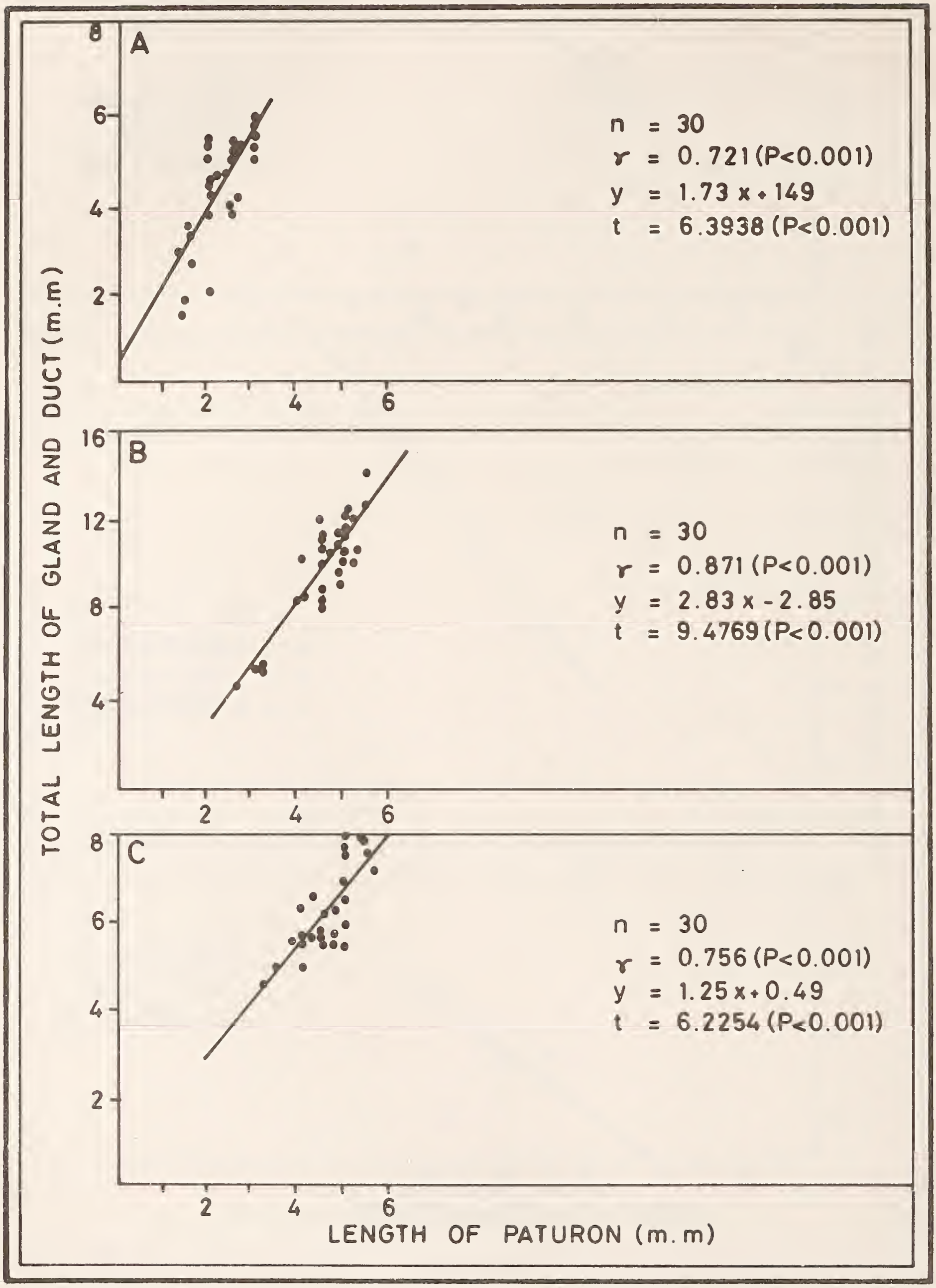


Fig. 5. Morphometric relationship of paturon length to gland and duct length for the three spiders: A: *Heteropoda venatoria*; B: *Lycosa indagastrix*; C: *Pleisiophirctus collinus.*

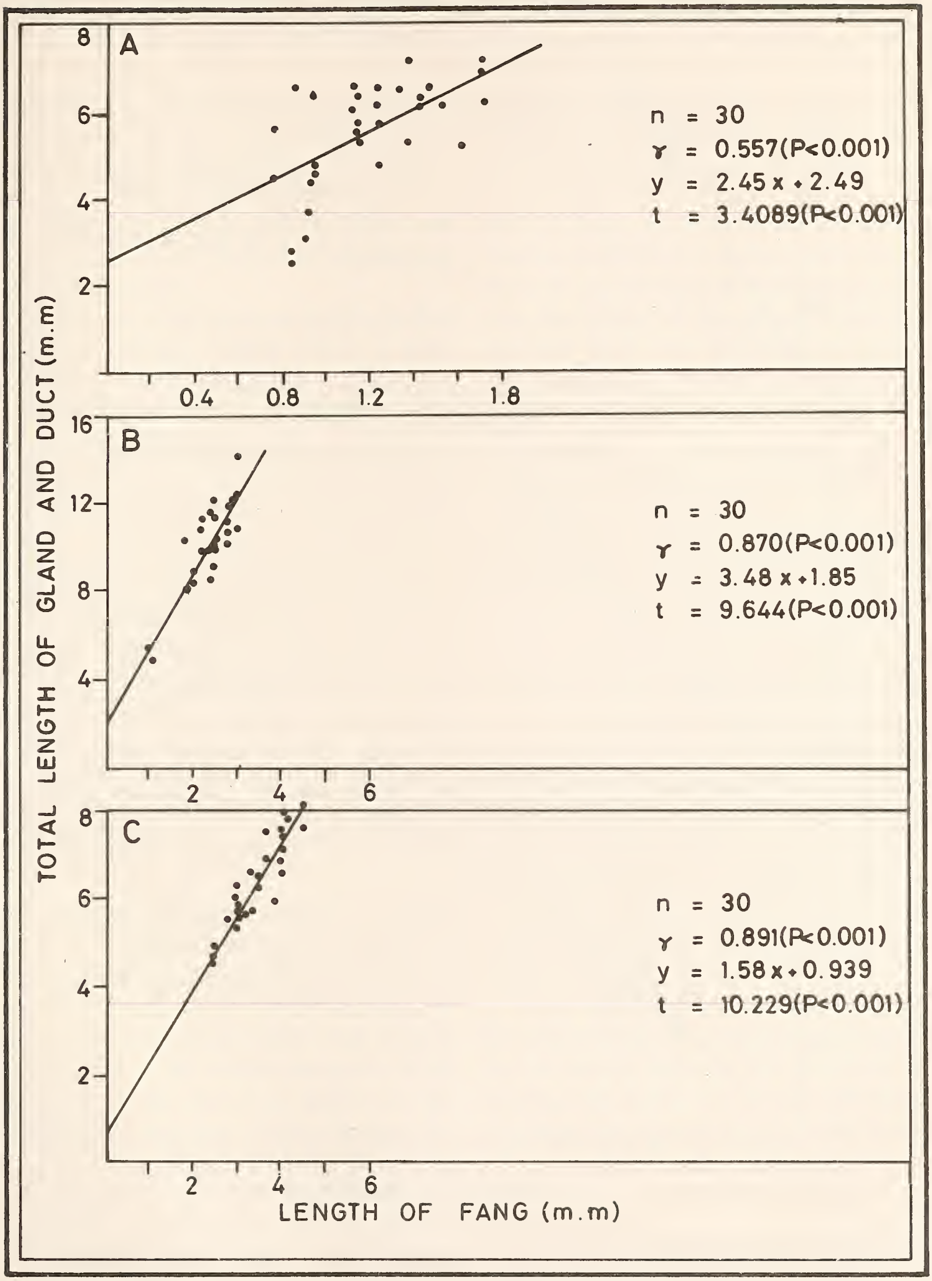


Fig. 6. Morphometric relationship of fang length to gland and duct length for the three spiders: A: *Heteropoda venatoria*; B: *Lycosa indagastrix*; C: *Pleisiophirctus collinus*.

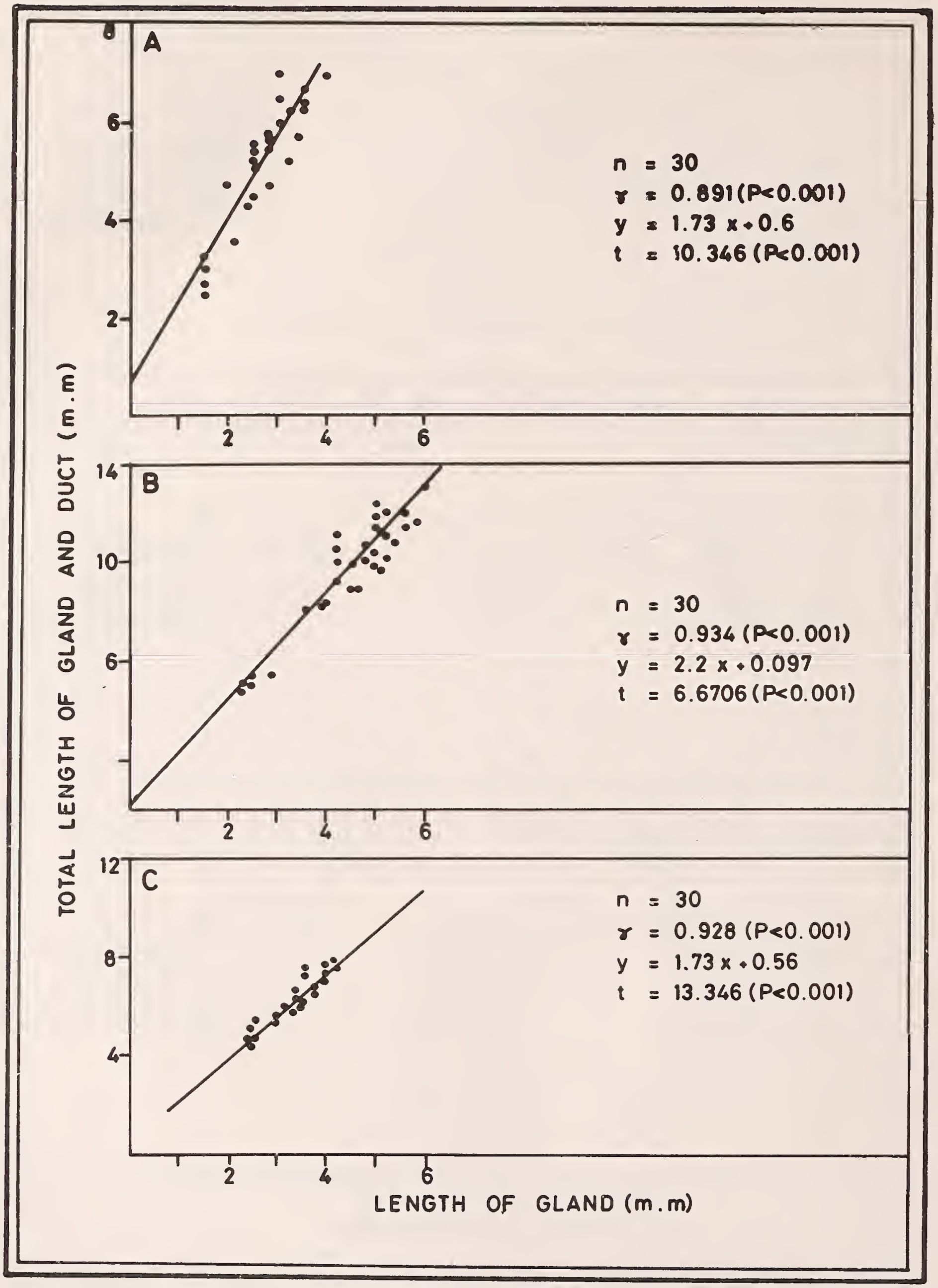


Fig. 7. Morphometric relationship of gland length to gland and duct length for the three spiders: A: *Heteropoda venatoria*; B: *Lycosa indagastrix*; C: *Pleisiophirctus collinus*.

the gland consists of two principal layers namely the outer muscular coat and the inner secreting layer. Hematoxylin and Eosin stains bring out very good differential staining of the glandular cells, their nuclei and the phases of venom secretion. In *Lycosa*, the muscles are arranged as distinct bundles and from space to space a small dense nucleus is seen mostly near the cell boundaries. The inner longitudinal muscle fibres are presumed to force out the venom by shortening the gland on contraction.

The inner surface of the muscles is attached to the basement membrane, which forms a continuous layer inside the muscularis. As observed by Reese (1944), the basement membrane is always distinct though it varies considerably in thickness during and after secretion. It seems to be a non-cellular sheet of connective tissue, varying from 1 to 3 m in thickness. In *L. indagastrix* the basement membrane bears several 'processes' penetrating into the central lumen and forming a network of fibrils. The cells of the glandular epithelium are attached to the basement membrane and few cells are seen attached to the fibrillar network of the basement membrane (Plate 2 a). These findings are similar to those of Brazil and Vellard (1925) for the glands of *Phoneutria*, and Millot (1931), for the glands of *Latrodectus mactans*, the most dreaded spider in the U.S.A.

The venom secreting cells form a simple epithelium in *H. venatoria*; where the cells are attached only to the basement membrane since the 'processes' are lacking. In the gland sections of unfed spiders the cells were filled with eosine droplets, presumed to be venom secreted. With the continuation of the secreting processes the cells are broken off and their fluids run into the central lumen. As illustrated in the light photomicrograph the venom glands of unfed spiders display a massive retention of large secretory droplets of varying degrees of density and size, virtually filling the entire lumen of the gland (Plates 2 b, 3 a).

The venom gland structure in *P. collinus* is similar to that of *L. indagastrix* in that the muscles are arranged as distinct blocks and the basement membrane is thrown into similar 'processes' for attachment of the secretory cells (Plate 3 c). It is hence presumed that in the large-sized and actively hunting spiders like *L. indagastrix* and *P. collinus* where the need for obtaining more food is always high, large amounts of venom should be readily available for capturing the prey. Therefore there are numerous basement processes extending into the lumen of the gland, which increase the surface area for accommodating numerous secretory cells. This was not observed in the comparatively smaller house spider *H. venatoria* (Plate 3 a).

As the secretory cells disappear after secretion of venom, it was concluded that the venom glands of the spiders studied are of the holocrine type, the entire cells with the secretory material being extruded and the cell dying ultimately. As the secretory cells undergo degeneration the basement membrane becomes thinner and acquires the appearance of a straight homogenous layer (Plates 2 c, 3 b). Bordas (1905) and Ancona (1931) described a similar holocrine secretory mechanism in *Latrodectus* and *Ctenus*. However Barth (1962) described a more complex and a non-regenerative sequence of secretory events in the venom glands of certain *Latrodectus* species.

While it is believed that *Latrodectus* is potentially more dangerous, no significant difference in gland structure has been observed.

It can therefore be concluded that though there are differences in the nature of muscle fibres and the secretory cells, in the glands of the spiders studied the mode of secretion of venom is fairly uniform, the venom glands being holocrine.

## ACKNOWLEDGEMENTS

I wish to thank Dr P.J. Sanjeevaraj for his valuable suggestions and for reading through the manuscript.

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# FLOWERING PHENOLOGY OF THE MANGROVES FROM THE WEST COAST OF MAHARASHTRA[1]

N.G. MULIK AND L.J. BHOSALE[2]

## INTRODUCTION

Mangrove ecosystems are under heavy pressure as a result of increase in human activity. The area under mangroves is getting reduced, and some important species are becoming extinct. Therefore, it is necessary to have a permanent record of its phenology. This type of study is almost nil along the coast of Maharashtra. The study of phenology is essential, as it has many applications such as in regeneration, afforestation, plant management, honey analysis, floral biology and the estimation of reproductivity. This study was based in Ratnagiri district, from where sites were selected on the basis of earlier ecological studies.

## MATERIAL AND METHODS

Three sites were selected for this study: Bandhkhind, Ganapatipule and Bhatye. At Bandhkhind there were some pure stands (populations) of *Sonneratia alba* and *Rhizophora mucronata* At Ganapatipule an important species, *Bruguiera gymnorrhiza*, was found. At Bhatye *R. apiculata*, *Avicennia marina* and *Kandelia candel* occurred. In all, twelve species of mangroves were studied. They are: *R. mucronata*, Lamk.; *R. apiculata* Blum.; *B. gymnorrhiza* Lamk.; *K. candel* (L.) Druce; *Ceriops tagal* (Perr); *Aegiceras corniculatum* (Linn.) Blanco; *Avicennia officinalis*, Linn.; *A. marina* var. *acutissima* Stapf and Moldenke; *Sonneratia alba* Sm.; *Excoecaria agallocha* Linn.; *Lumnitzera racemosa* (Willd.); *Acanthus ilicifolius* Linn. Phenophases were observed every fortnight for each species and monthly variations were recorded. Phenophases like initiation, budding, blooming, fruiting and seedling development were noted. Continuous observations from April 1983 to May 1985 were made to collect data.

## RESULTS AND DISCUSSION

In most of the mangrove species flowering commences in the summer months (Jones 1971, Graham *et al.* 1975, Byrnes *et al.* 1977 and Saenger 1982). It was noted during our field observations that *R. mucronata*, flower primordia develop on the young plant when it is about four years old. Gill and Tomlinson (1969) reported a similar period. However, they noted flowering in *R. mangle* when it was one metre in height. Nevertheless, data on floral initiation in mangroves is very scanty. In the present study initiation of flowering was recorded during the month of December for *R. mucronata*. It was maximum in January and continued in February. There was a slow increase in budding in the beginning, followed by a sharp increase from April to May. *R. mucronata* flowers heavily during September to November but blooming actually starts in July and then continues throughout the year. Mature propagules were found hanging on the mother plant in May-June in maximum numbers. The whole cycle continues throughout the year.

The phenology of *R. apiculata* is interesting. Initiation is observed in the beginning of May. It continues for quite a long time, up to August and even later. Budding stage is found very late, and is recorded up to September. After such a slow initial development of reproductive parts there is a steep increase and maximum blooming was noticed in October. All the phases in *R. apiculata* overlap and throughout the year one or the other stage is observed. The fruit, once formed, matures within 2–3 months and then the vivipary starts

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appearing. By the end of August all mature propagules are shed. According to Christensen and Wium-Anderson (1977) the period required from primordia formation to propagule maturation in *R. apiculata* is three years. In the present study this has not been observed. If the propagular development is a long process, the presence of "germinated fruit" on the mother plant throughout the year is essential.

In *Bruguiera gymnorrhiza* initiation is recorded at the beginning of January and continues up to April. There is a slow increase in flowering initially, followed by a sharp increase from mid-January to February. There is a sharp decline in flowering which almost ceases in the beginning of February and shows a sudden increase to a maximum in April–May, followed by a steady decline. In December different developmental stages are found. The propagules are recorded from June to August. The observation that the flowering in *B. gymnoryhiza* commences in the summer months supports earlier reports (Jones 1971, Graham *et al.* 1975, Specht *et al.* 1977).

*Kandelia candel* flowers and fruits simultaneously, and mature propagules can be seen when the plant starts flowering during the following year. Initiation is recorded from December to February, and is also seen in August–September as a second phase. Flowering peak is recorded during February–March. Thereafter there is a sharp abatement, with decreasing yields of reproductive material recorded until the end of August. In *K. candel* the total development period calculated according to our observations is nearly 10–12 months. The development period is similar to that recorded by Nishihira and Urasaki (1976); i.e. 12 months from flower buds to mature propagule. The total developmental time from bud to seedling stage is about six months as reported by Wafar (1985). However, in the present investigation the period observed is much longer.

It is interesting to note the floral initiation in two phases. When it starts in August–September, the propagule matures within 10 months. However, when it takes place in December–February, the time taken for development of the mature propagule seems to be greater. It was not possible to make any observation with this phase of development. Looking at the other members of Rhizophoraceae which take almost a year for development of the mature propagule, it appears that *K. candel* may not produce a fully developed propagule within six months (December–June). Further investigation is in progress.

In *Ceriops tagal*, floral initiation was recorded during April, and continued up to August. Simultaneously the next phase, budding, starts. Bud formation was observed from May to September. Blooming is found throughout the year. The maximum flowering was found in September and October. From April to June, heavy fruiting was observed. The mature propagules of *Ceriops* are recorded from June to August. The time required for the development from floral bud to mature propagule is more than a year. This is similar to the observations of Wium- Andersen, and Christensen (1978) who found that the development from floral bud to fruit takes about 12–18 months. It is evident from the data that in *Ceriops* also budding, blooming and fruiting occur year round and that phases, one after the other, continue the cycle. It should be noted here that the propagules shed from June to August are developed from the fruits of the preceeding year.

*Sonneratia alba* shows floral initiation as early as December, continuing up to February. Again, initiation is recorded during June–July (early monsoon). Budding is recorded from January onwards till the end of August. Flowering appears in January and continues up to October, with a first peak in March and a second peak in June. It is evident from the data that in *Sonneratia* also all phenophases overlap and continue throughout the year.

The floral buds in *Sonneratia*, after their appearance, open into flower within 1–1.5 months. Flower to fruit development takes about 4 to 6 months, and the maturation of fruit takes nearly two months. Thus the total period of mature seed formation in *Sonneratia* is about 12 months. Only a few fruits are observed on the plant, and out of all the flowers formed only a few develop into fruits.

*Avicennia officinalis* and *Avicennia marina* both showed different patterns in their phases. In *A. officinalis* initiation is recorded from early January up to the end of February. The phenophase of *A. officinalis* reveals that the flowering period is short when compared to other genera. Budding appears during February and extends up to May. Flowering begins in March and extends up to July. The maximum number of flowers occur during April–May and fruits from June to early August. The developed seedling inside the mature fruit is released and falls to the ground from June to early August, when it starts establishing itself. From September to December there is a complete vegetative stage of the plant. No other phenophases were observed during this period at any of the sites under study.

In *A. marina* floral initiation is observed from January to April and flowering begins in early March, reaching a maximum in May. Fruit initiation starts in early April and extends up to September, i.e. flowering and fruiting come to an end towards late September. Seedlings are found on the soil from August to early October. In *A. marina* community, litter yields of leaves and reproductive material an showed increase from mid March to the end of April in South Africa (Steinke and Charles 1984). Similar patterns of flowering and fruiting phenophases are recorded in the present study.

*Excoecaria agallocha* is dioecious, bears flowers in catkins, possesses 2–celled pollen grains, and is presumably wind pollinated. No detailed information is available on the phenology of mangroves. Flowering was recorded in *Excoecaria* in a 2 year old plant. During the vegetative stage it is difficult to distinguish between male and female plants. Floral initiation in male plants of *Excoecaria* occurs during March and in female plants in the month of November, then again initiation stage is recorded during April and May in both sexes simultaneously. Buds of female flowers and young male catkins start appearing during April–May and real blooming occurs during May to June. Fruiting stage starts from July, and continues up to end August. In September, different seed developing stages are seen. Seeds start maturing from September. During September to October very young seedlings were observed on the soil.

The floral initiation in *Lumnitzera racemosa* was observed between November and February. Budding begins in January and culminates with a decline in May, and is again seen between June and September. Flowering occurs from March to April and extends up to October. Simultaneously fruiting is also recorded during the months of February to December. Maximum fruiting is recorded during July and August. The seeds of different stages such as very young, as also mature, are seen during September to December. All phenophases, except initiation, are seen in July and August.

*Aegiceras corniculatum* is a much branched shrub, which inhabits areas that are inundated by normal high tides. Flowers of *A. corniculatum* are scented and are an important source of honey. In this species flowering was first observed at a height of 0.27 m by Steinke and Ward (1973).

Initiation starts in early September and ends in early November. Again in January and February initiation is recorded in a few plants. Budding is seen during November to February. *Aegiceras* starts blooming in early December and ends in early April. Fruiting stages are between late December to July. Mature fruits (cryptoviviparous) are recorded from May to early August. In general, the reproductive phase in *Aegiceras* is restricted to a period of a few months. Analysis of the data reveals that flowering and fruiting comes to an end towards late summer. The mature fruit contains a well developed seedling inside (cryptovivipary). From late June to early August these fruits are shed. They can be called as propagules.

*Acanthus ilicifolius* is a small shrub that grows well in open mangrove areas. In *Acanthus* two distinct phases are observed, the vegetative and the reproductive. The vegetative phase takes three months, September to November. Then there is transition from vegetative to reproductive growth. Initiation is restricted to December and January only. Bud formation is found from January to March. Maximum flowering is recorded towards the end of March and April. Not all flowers open at the same time. Therefore, the 'Blooming' period is recorded from January to May. Fruiting is from April to July. During June–July different fruit development stages are observed. Fruits with mature seeds are found from June to July end. The seeds are released by dehiscence of fruit on the plant; after this beds of seedlings are found all over the area. No seed can be seen on the plant after the first week of August. Jagtap (1985) has reported flowering in *Acanthus* during August. In the investigation, in spite of several attempts no seeds were observed during late August. Flowering was found to be completed still earlier.

Phenological rhythms such as flowering or fruiting vary from one species to another in a given locality (Blasco 1984). Some species of *Avicennia* flower at the end of the dry season (March–April–May), whereas the flowers of *Bruguiera cylindrica* are collected in September–October (end of the rainy season) and those of *Lumnitzera* mainly during November to January (winter).

The twelve mangrove species analysed in the present investigation have revealed different patterns of phenophases. Different species of mangroves have adapted differently. In Rhizophoraceae members in all stages of development can be found throughout the year. Gill and Tomlinson (1969) have reported *R. mangle* as flowering throughout the year.

Uptil now little information is available on the initiation of flowering. The present data gives an idea about the initiation phase among twelve mangroves, which is important for further ecological studies. The occurrence of propagules in mangroves in Ratnagiri district is maximum in summer. In some species the time from flower to mature propagule varies greatly. Since leaf production in *Rhizophora* is also seasonal, with a maximum during summer (Christensen and Wium-Anderson 1977; Gill and Tomlinson 1971), it seems that fruiting is limited to the period most favourable for growth. In a region with alternating seasons, the life cycle of plants is synchronised to the long term changes in the weather (Larcher 1975). Flowering period in *Halophila* occurs over ranges of temperature and day lengths but is reported to show strong correlation with the nutrient conditions of water (McMillan 1980). In *Cymodocea* flowering is reported to be strongly influenced by high temperature (31°/27°C Day/Night).

Hence, flowering in mangroves is expected to be controlled by an interaction of temperatures and photoperiod conditions. There is response to longitudinal distribution by mangrove species with respect to flowering. It is found in the present investigation that flowering and fruiting in *Aegiceras corniculatum*, which is distributed only over a few months, is later by about a week at Ganapatipule than at Bandhkhind. This may be attributed to the difference in longitude of the two places–Ratnagiri (17°0' N, 73°2' E) and Ganapatipule (17°9' N, 73°2' E). In all the mangrove species along the Goa coast, extensive flowering was noticed during March to June and extensive fruiting during April to July. Flowering and fruiting was observed to be generally poor or absent during September to January. An extensive flowering during March to June may be attributed to higher temperatures and longer duration of light (photoperiod). Thus the phenological characteristics of mangrove species are related to different environmental factors.

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# STATUS AND DISTRIBUTION OF THE KING VULTURE *SARCOGYPS CALVUS* (SCOPOLI) IN GUJARAT: RESULTS OF A RECENT ENQUIRY[1]

Shivrajkumar Khachar[2] and Taej Mundkur[3]

*(With a text-figure)*

The present distribution of the King Vulture *Sarcogyps calvus* in Gujarat state is mapped on the basis of 50 sightings of the the bird made by 23 birdwatchers and naturalists during 1982 to 1987. The available information indicates that the bird's range has shrunk considerably in recent times and that it must be put on the list of endangered species in Gujarat.

## INTRODUCTION

The King Vulture *Sarcogyps calvus* (Scopoli) is resident to the entire Indian subcontinent and is found up to an altitude of about 2000 m in the Himalayas. It is sparsely distributed and nowhere very abundant (Ali and Ripley 1983). In Gujarat, the bird was common in the Kutch region (Ali 1944) and the Saurashtra region (Dharmakumarsinhji 1955), and was seen in small numbers throughout the state (Ali 1954). In the last decade or so the number of sightings seemed to have diminished sharply and nesting was rarely observed. A survey was therefore undertaken to study the present distribution and status of the King Vulture in Gujarat.

## MATERIAL AND METHODS

In 1982, alarmed by the absence of sightings of the vulture in areas where it was frequently seen in the past, one of us (S.K.) started an enquiry on the status and distribution of this unmistakable bird in Gujarat. A questionnaire soliciting information was sent to known birdwatchers. A short write-up with a picture for identification was published in the local newspapers, Newsletter of the Gujarat State Committee of WWF-India, and Newsletter for Birdwatchers, requesting information. Records of sightings came from birdwatchers in various parts of the state, and officials of the State Forest Department kept a look out for the bird. The data thus collected were carefully scrutinized and compiled to form the basis of this report.

## RESULTS AND DISCUSSION

Fig.1 summarizes the sightings of the King Vulture recorded from 1982 to 1987. The sightings have been mainly restricted to the semi-arid to arid regions, namely the Kutch, Jamnagar, Rajkot, Junagadh, Bhavnagar, Surendranagar, and Banaskantha districts of the state. The Gir Forest in the Junagadh district registered the maximum number of sightings. The second stronghold is in Kutch, mainly around the Kaladungar on the south of the Great Rann and along the edges of the Little Rann. The sightings have been typically of one or two birds, except for a single gathering of 6 birds recorded at Amrutvel in the Gir Forest on 31 March 1983. This supports the understanding that the bird is solitary in habit, and is far outnumbered by the other common species of vultures (Ali and Ripley 1983).

In the past, one of us (S.K.) has known the bird to nest near Jasdan (Rajkot district) and in Bhavnagar (Bhavnagar district), and watched its spectacular nuptial display and mating. The bird does not nest there any more. As a matter of fact, there are very few records of its nesting in Gujarat in recent times; one active nest near Zainabad on the eastern border of the Little Rann was recorded on 27 February 1987 (E. Foster, pers. comm.), and two unconfirmed reports of nesting near the village of Baid (Jamnagar district) on 4 December

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[1] Accepted November 1987.

[2] Darbargadh, Jasdan, Gujarat-360 050. (Deceased)

[3] Department of Biosciences, Saurashtra University, Rajkot-360 005.

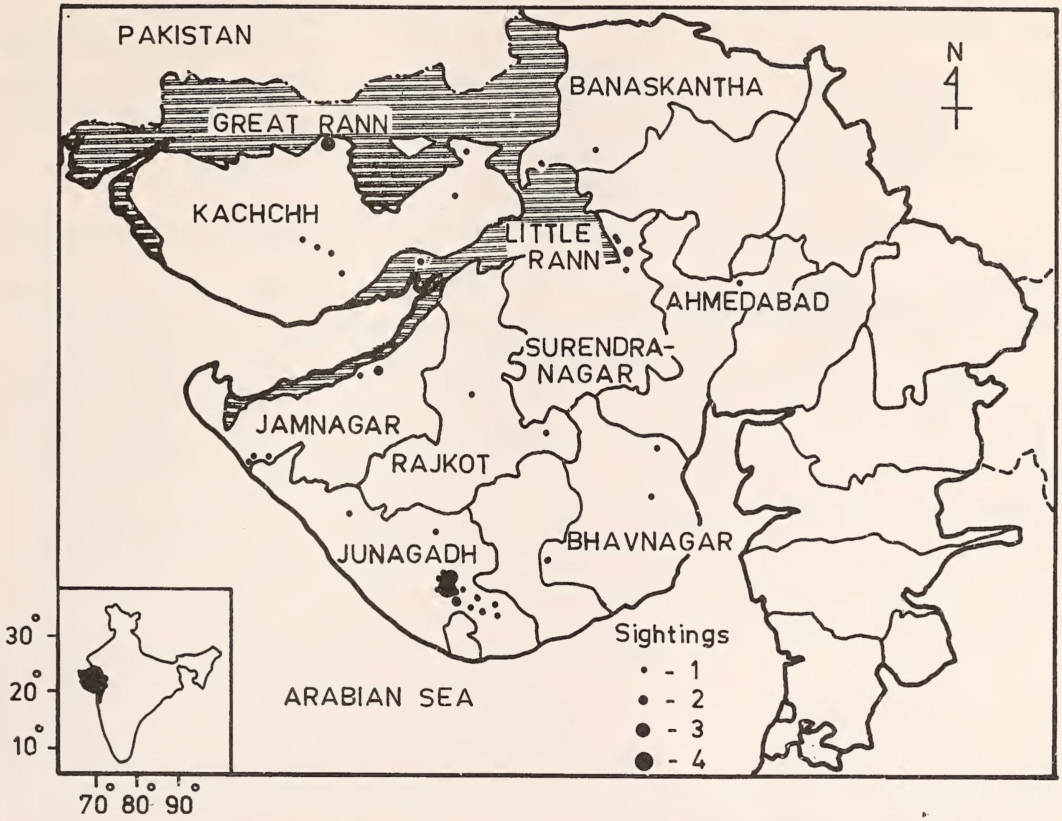

Fig.1. Outline map of Gujarat State. Inset gives outline of India, with Gujarat state darkened. Stipled area shows the Great & Little Rann of Kutch and low lying coastal marshes. The location and number of sightings of the King Vulture is represented by closed circles as explained in the scale.

1985 (N.M. Mashru, (pers. comm.). One nest was found in a tree on a cliffside at Mitiala (Bhavnagar district) during 1975—1976 (S.K. Goyal, pers. comm.).

This study does not reveal the size of the vulture population in Gujarat, but it clearly shows that the bird's range has reduced drastically. From the available information it does seem that this vulture is endangered in this state. The scanty records of nesting are of grave concern. The bird is known to nest on trees, often short trees. There has been a continued and rapid increase in the human and domestic livestock populations, and the livestock is often fed with branches of trees, particularly *Acacia*, so that safe nest sites for the vulture have become a scarce commodity. The loss of nesting habitat in this region seems to be the main cause for a decline in number of large—sized tree nesting avian species in general, which would include most of the raptors, storks, herons and ibises.

It is just possible that the King Vulture may also be using cliff edges on hills for nesting, though such a nesting habit has not been recorded so far. Concentration of birds observed around the Kaladungar, the tallest hill in Kutch, and Girnar hill in Junagadh district, indicates the possibility that at present the bird may be using cliff ledges more often than trees for nesting.

## ACKNOWLEDGEMENTS

We are very grateful to A. Babi, R.B. Balar, A.K. Banerjee, M.T. Daswani, N. Dave, M.K. Dharmakumarsinhji, E. Foster, S.K. Goyal, N.

Jhala, K. Joshi, L. Khacher, D. Khant, H.K. Lalka, Dr N.M. Mashru, A. Mashru, Dr B.M. Parasharya, I.D. Sama, S. Sayyed, S. Shah, A.K. Sharma, S.P. Sinha, R.M. Vadhavana, A.A. Vaidya and S.N. Varu, who responded to our enquiry and made this study possible. P. Pandya and N. Jhala from the office of WWF—India, Saurashtra branch, kindly gave their help in organising this survey. We are grateful to Dr R.M. Naik for critically commenting on earlier drafts of the paper.

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# SPAWNING IN THE FROG *MICROHYLA ORNATA* (DUM. & BIBR.)[1]

A.D. PADHYE AND H.V. GHATE[2]

(*With eight figures in two plates*)

Spawning behaviour of the ornate microhylid frog, *Microhyla ornata* (Dum. & Bibr.) is described for the first time. Observations regarding calling, amplexus and spawning are recorded. Data on spawn appearance, spawn size and egg size is presented.

## INTRODUCTION

*Microhyla ornata*, commonly known as ornate microhylid, belongs to family Microhylidae. This family includes narrow- mouthed frogs which differ from the members of families Ranidae and Rhacophoridae by the absence of teeth in the upper jaw. In contrast with the members of Bufonidae, these have more smooth skin, oval tongue and circular or vertical pupil. According to Daniel (1963) there are five genera representing family Microhylidae in Western India, and the genus *Microhyla* is represented by two species, namely *M. ornata*, and *M. rubra*. Very little information about the bioecology of this group of amphibians is available. In the case of *M. ornata*, the observations of earlier workers (for example Ferguson 1904; Rao 1917 and McCann 1940) have also been discussed by Daniel (1963). Mohanty-Hejmadi *et al.* (1980) described in brief the early development of this species. We are reporting here some observations about the spawning behaviour of this frog. Information about the spawn proper is also given.

## MATERIAL AND METHODS

A large number of stone quarries, semi-permanent ponds and temporary rainwater pools were surveyed extensively during the years 1986 and 1987. During monsoon a large number of observations were made on the spawns of *Microhyla* at various places. Spawn characteristics, egg characteristics, and physico-chemical parameters of the pond water were studied. Climatological factors were also noted for various days.

Several observations were made at night to understand spawning behaviour of the frogs from Kothrud area, Pune (Fig. 1). This area, situated in the southwest of Pune, is as yet considerably free from industrial activity as well as general human interference. Further, the area still harbours a good population of *Microhyla ornata*. There is also an abundance of subterranean, wingless termites, which provide essential food to this fossorial frog.

## RESULTS AND DISCUSSION

The frog is a seasonal breeder, breeding only during the monsoon. Depending on the rainfall, the breeding season extends from June to September. Naturally fertilized eggs were observed right up to late September, during the 1986-87 survey. The survey of different localities in and around Pune showed that the majority of *Microhyla* breed in temporary rainwater pools, while others breed in disused stone quarries, which often have water almost throughout the year due to natural streams. In addition, these quarries are flooded with rainwater during monsoon.

During the breeding season the adults were frequently found very close to such water bodies, usually one hour after sunset. The activity and calling began late in the evening, around 2000 hrs. Despite its small size, the male was found to have a loud and distinct vocal call, as noted by some workers (Daniel 1963). The sequence of events of amplexus and spawning were as follows:

Loud chorus of frogs started at about 2030 hrs. The males called from under bushes of *Lantana*

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[1] Accepted February 1988.

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near the pond. While calling, the male looked like a balloon, as the single, subgular vocal sac was inflated to its full capacity (Fig. 2). In four cases the calling male was recognized by nearby females. The recognition must be only on the basis of the call, as is true of many anurans, especially when the species are nocturnal and are without distinct colour patterns in males and females; although olfactory and other cues may be important as well (see the excellent discussion in Duellman and Trueb 1986). As the female approached and came in contact, the male stopped calling and the pair formed amplexus right by the side of the pond, at about 2330 hrs (Fig. 3). The male was above and was holding the female just behind the pectoral girdle. The cloacal regions of both were closely approximated (Fig. 4). When an amplexed pair was collected from the bushes around the pond, it was observed that they were glued to each other and could not be easily separated (Fig. 5). The amplexed pairs later jumped into the water. Around 0230 hrs spawning took place. The eggs were released in three or four convulsions and while doing so the heads of the pair dipped into the water. The process of spawning was over within 3 to 5 minutes and the pair separated almost immediately. The release of sperms could not be clearly observed; however, the eggs were later observed in the laboratory and found to be fertilized. Although the amplexing pair separated immediately after the release of the eggs, the amplexus itself lasted for about 3 hours. Close observations under the hand lens revealed that the male was firmly attached to the back of the female. One such pair, collected prior to spawning, did not separate even when chilled and fixed in formalin.

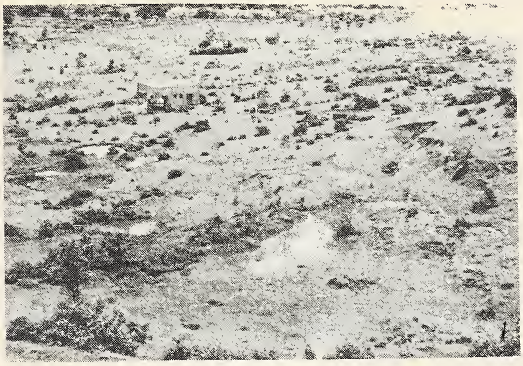
This type of amplexus is described as axillary and is known to be a common method in most anurans (Duellman and Trueb 1986). Attachment of the male frog to the back of the female has been reported in other microhylids as well. For example, in *Breviceps*, another microhylid, amplexus is reported to last for three days (Wager 1965). This is because the male and female remain glued to each other due to adhesive secretions of some specialized cells of the skin in males, as shown for the other microhylids by Conaway and Metter (1967). Duellman and Trueb (1986) have also pointed out similar cases where glandular secretions may be playing a role in amplexus formation. It remains to be seen what type of glands are present in *M. ornata*.

In general, the chronological sequence of the events associated with spawning was: Calling started: 1930 to 2000 hrs; beginning of a loud chorus: around 2030 hrs; continuous chorus up to 2300 hrs; chorus with intermittent periods of silence indicating mate recognition leading to amplexus formation: 2300 hrs onwards; amplexus formed near the pond 2330 to 0100 hrs; amplexed pairs found in water: around 0200 hrs; spawning 0200 to 0400 hrs.

The spawns were generally found at the periphery of the pond, floating on the surface of water, usually among the emergent vegetation (Fig. 6). Each single spawn is a rounded, transparent mass of eggs. The eggs are in a monolayer (Fig. 7). Each fertilized egg is enclosed in a vitelline membrane which is further covered by a layer of jelly of variable thickness. The individual eggs, due to their jelly mass, are further attached to other eggs that surround them to form a mat of uniform meshwork (Fig. 8).

The number of eggs per spawn was highly variable but on an average the spawns collected during 1986 and 1987 contained 511 eggs (Table 1). The eggs are generally brownish at the animal pole and hence very well camouflaged in the plankton–rich waters of the pond. The vegetal pole is pale yellowish in colour. These characteristics are typically that of any anuran spawn. Sometimes colour variation was observed in the eggs; absolutely pale coloured eggs were also recorded twice during 1986.

The mean egg diameter, based on measurements of about 50 to 75 eggs at late gastrula stage from different spawns was: diameter without jelly — 1.22 (0.08± ) mm and with jelly — 4.03 (0.75± ) mm. The mean egg diameter recorded by Mohanty-Hejmadi *et al.* (1980) is 1.1 mm; while Ferguson (1904) recorded the diameter to be 2.0



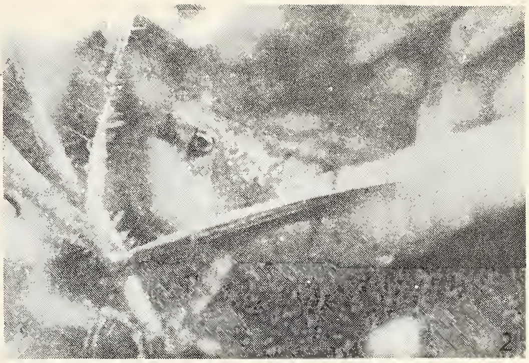


Fig. 1. A typical habitat of the frog *M. ornta*, near Kothrud, Pune. Note shrubby vegetation in an otherwise barren area. Temporary rainwater pools where the present work was carried out are also seen.

Fig. 2. The calling male with inflated vocal sac.

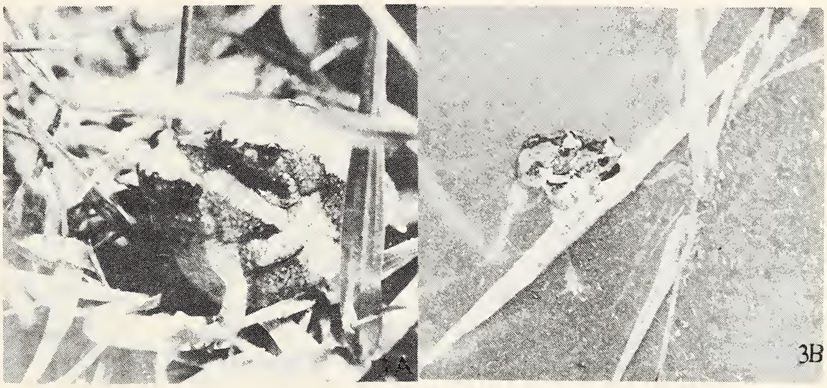
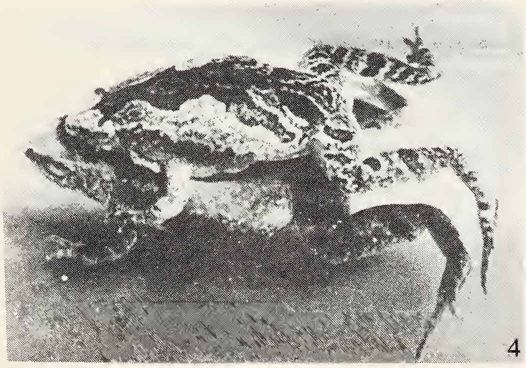


Fig. 3. Amplecting pair near the pond (A) and a pair floating in water (B).



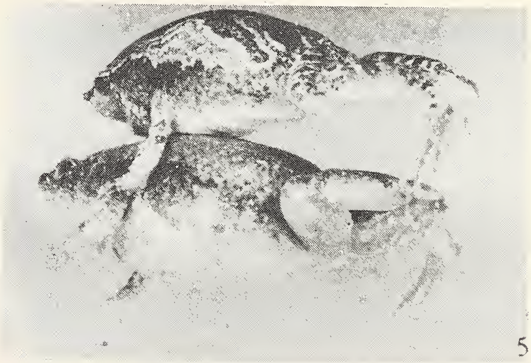


Fig. 4. Close-up of an amplecting pair. Note that the pattern is axillary.

Fig. 5. Lateral view of the amplexus showing the male glued to the back of the female.

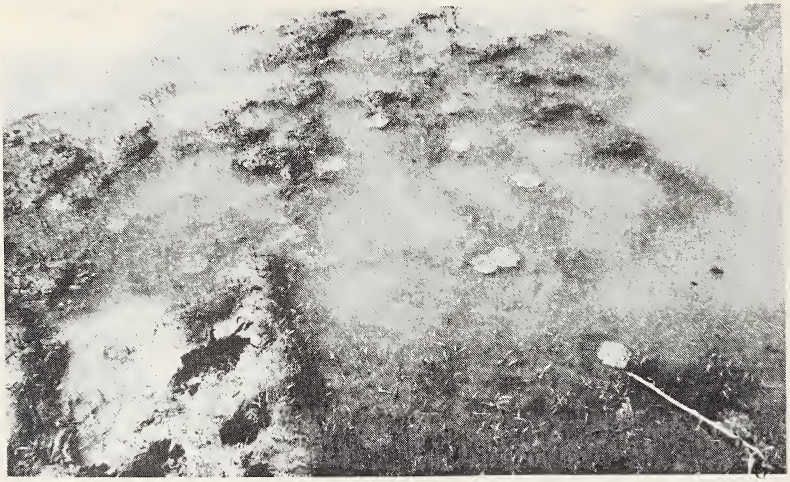


Fig. 6. Several spawns floating on the surface of water. A closer spawn is pointed.

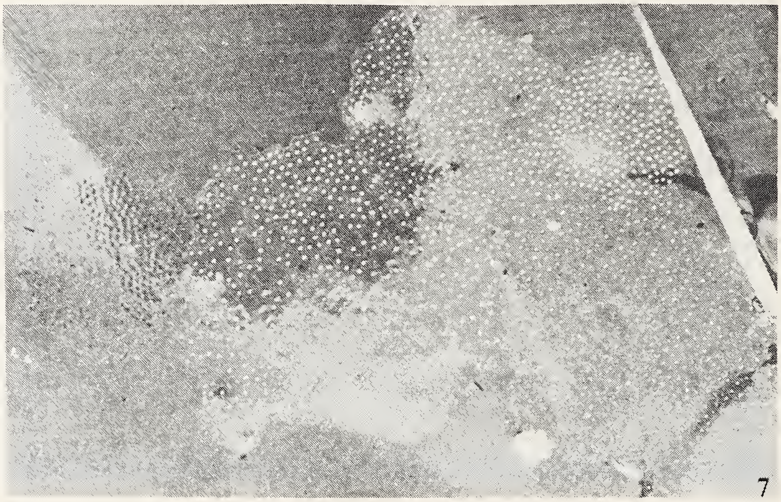


Fig. 7. The spawn. Note that the eggs are in a monolayer.

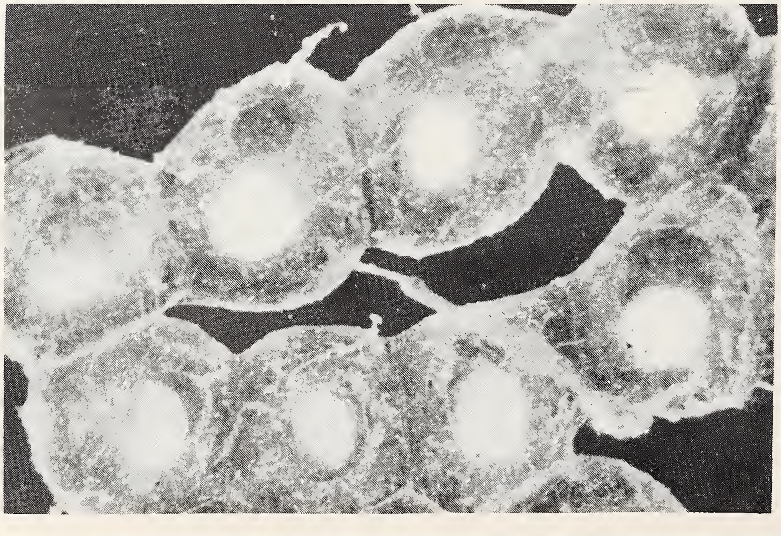


Fig. 8. Close-up of the spawn to show the attachment in between the individual eggs.

TABLE 1
NUMBER OF EGGS PER SPAWN IN A FEW RANDOMLY COLLECTED SPAWNS DURING 1986 AND 1987

| Date | Number of eggs per spawn | Date | Number of eggs per spawn |
|---|---|---|---|
| 6 Aug 1986 | 179 | 14 Aug 1986 | 642 |
| | 510 | 19 Aug 1986 | 917 |
| 7 Aug 1986 | 730 | 22 Aug 1986 | 567 |
| | 947 | 23 Aug 1986 | 129 |
| | 405 | 24 Sep 1986 | 152 |
| | 1028 | | 548 |
| 8 Aug 1986 | 765 | 17 Jun 1987 | 747 |
| | 133 | | 527 |
| | 62 | | 218 |
| | 506 | | 367 |
| 9 Aug 1986 | 1327 | 25 Jun 1987 | 463 |
| | 599 | | 388 |
| | 65 | 26 Jun 1987 | 119 |
| | 612 | 30 Jun 1987 | 247 |
| | 723 | 8 Jul 1987 | 696 |

Mean 511 eggs per spawn, S.D. = 314.

mm. The record of Ferguson is ambiguous since no mention is made whether the jelly cover was included or not. Mohanty–Hejmadi *et al.* (1980) have not given the estimates of spawn size. However McCann (1940) recorded the number of eggs per spawn to be approximately 200. We have observed that the spawn size may be as small as 62 eggs or as large as 1327 eggs. We have also observed that the spawns collected early in the season are larger than those at the close of the season. It is possible that the smaller spawns are second or third spawns of the female. Although no clearcut evidence is available, each mature female probably lays eggs twice or thrice in one season. Another observation in this regard concerns the thickness of the jelly around the eggs. Earlier spawns were found to have firmer and thicker jelly while those of the later period showed a very thin, loose layer of jelly. Multiple clutches in a single season are reported in anuran amphibians (Wells 1976, Perrill 1983). In fact, it is suggested that capacity to breed twice or more in a single season may be one of the major advantages of a prolonged breeding season (Wells 1976).

The temporary rainwater pools (ponds) observed during this survey were variable in size and depth. On an average the depth of such ponds never exceeded one metre. The surface area of the pond was variable.

Peak spawning activity was noted seven times during the survey. The number of spawns observed on these days and the climatological parameters recorded for the previous day of the spawning are given in Table 2. It was interesting to note that in a very small temporary rainwater pool with a diameter of about 10 metres and water depth of less than a metre, there were 113 spawns on a single day. In general all these peak spawning days were preceeded by a prolonged dry period of

TABLE 2
PEAK SPAWNING ACTIVITY AND CLIMATOLOGICAL FACTORS
ON PREVIOUS DAY OF SPAWNING.

| Date | No. of spawns Pond 1 | & Pond 2 | Pond water temperature in Celsius | Temperature Max. | Min. | Relative Humidity | Rain-fall in mm |
|---|---|---|---|---|---|---|---|
| 8 Aug 1986 | 14 | 21 | 25.0 | 25.5 | 21.8 | 90% | 4.1 |
| 9 Aug 1986 | 27 | 45 | 22.0 | 24.8 | 1.5 | 92% | 6.1 |
| 17 Jun 1987 | 62 | 42 | 23.0 | 31.3 | 22.8 | 86% | 6.0 |
| 25 Jun 1987 | 38 | 26 | 22.5 | 32.3 | 24.3 | 84% | 18.6 |
| 8 Jul 1987 | 113 | 45 | 23.0 | 26.6 | 21.8 | 82% | 21.0 |
| 17 Aug 1987 | 104 | 16 | 21.5 | 29.0 | 22.6 | 93% | 142.0 |
| 27 Sep 1987 | 50 | - | 22.5 | 31.1 | 21.6 | 92% | 5.5 |

about 10 days. Further, spawning activity was also observed at other times during the season, except during prolonged dry period. Generally, when a large number of temporary rainwater pools were formed after a heavy rainfall, the spawning continued for a week or so even if there was no heavy rain but the atmosphere remained cloudy and humid. Rainfall during the night was not always essential for the spawning to take place.

The other habitats in which fertilized eggs of *M. ornata* were found consistently were old, disused stone (basalt) quarries with natural streams. Of such places, very few are now free from human interference. Most of them are being used for a variety of purposes such as for washing clothes and utensils and are thus grossly polluted with anthropogenic wastes. Some of them are almost becoming eutrophic and contain a fair amount of detergents, optical whiteners and related chemicals. Even cattle are washed regularly in such water bodies, adding organic matter that further helps eutrophication. It is unlikely that such water bodies would be of any use to the frogs and toads in future, although a few spawns were found even in grossly polluted waters. In this context it may be pointed out that previous workers have noted a decline in the population of local frogs and attributed it to the destruction of habitat and proper breeding sites (Paranjape and Ghate 1986). This is also the case elsewhere (see Duellman and Trueb 1986).

Hatching success, under field as well as laboratory conditions, was observed to be about 95%. The majority of the eggs are thus fertilized eggs. High fertility is essential for the frogs which produce fewer eggs per spawn. Other aspects of the developmental ecology of this frog have also been studied and will be presented separately.

## ACKNOWLEDGEMENTS

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# ROLLAPADU WILDLIFE SANCTUARY, WITH SPECIAL REFERENCE TO THE GREAT INDIAN BUSTARD *ARDEOTIS NIGRICEPS* (VIGORS)[1]

RANJIT MANAKADAN AND ASAD RAFI RAHMANI[2]

*(With two maps and a text-figure)*

## INTRODUCTION

The Rollapadu Wildlife Sanctuary is the most well-known place for the Great Indian Bustard *Ardeotis nigriceps* (Vigors) in Andhra Pradesh. The Sanctuary was established mainly due to the recommendations of the Endangered Species Project of the Bombay Natural History Society to the Andhra Pradesh Forest Department. The Society had a field station from September 1985 to May 1988 at Rollapadu. We give here an account of the Sanctuary, its flora, and fauna with special reference to the bustard, in an effort to provide baseline data for future researchers at Rollapadu.

## LOCATION AND TOPOGRAPHY

Rollapadu is a small village (population 755, vide 1981 census) 18 km south-east of Nandikotkur town (15° 52'N ' 78° 18'E) in the plains between the Nallamalai and Erramalai ranges of the Eastern Ghats. The River Krishna flows northwest of Nandikotkur. The rocks belong to the Kurnool-Cuddapah formations. The soil is gravelly with heavy clay content and low permeability. Black cotton soil, preferred for agriculture, also occurs in the surrounding areas.

## CLIMATE

The first three months of the year are pleasant with moderate winds from the southeast. The summer heat starts at the end of March, and April and May are the hottest months with temperatures soaring to 42° C. Towards the end of April, Rollapadu experiences dust storms accompanied by a few showers, giving respite from the heat. Rainfall is received from the SW and NE monsoons, with an average annual rainfall of 667.8 mm which varies from year to year. Cyclonic storms that hit the Andhra coast almost every year, especially during the NE monsoon period, result in continuous downpours at Rollapadu. Winter is mild and the coldest month is December (*c.* 18° C).

## CONSERVATION MEASURES

After the 'rediscovery' of the bustard in August 1982, the Forest Department stopped all trapping activities. In 1983, on learning that the bustard frequented areas were to come under a sheep farming scheme, the Department took steps to acquire these lands. In April 1988, the acquired lands received the official designation of a sanctuary. The staff consists of a Forester, a Guard and seven watchmen. The Sanctuary is under the jurisdiction of the Conservator of Forests, Srisailam.

The area of the Sanctuary is 614 ha, divided into three blocks or enclosures. These enclosures are out-of-bounds for people and livestock and are bordered by trench-cum-mound walls (TCM). A system of roads, again bordered by TCM walls were also laid out in the enclosure to regulate the movement of people to their crop fields or villages–the right of way in the enclosure (along the roads) had to be ceded to the villagers as it was a traditional pathway and a route round the enclosure would put them to much difficulty and evoke antagonism for the Sanctuary. These roads, besides minimizing disturbance to the bustards, also act as fire breaks. A waterhole is present to help the animals tide over the hot summer.

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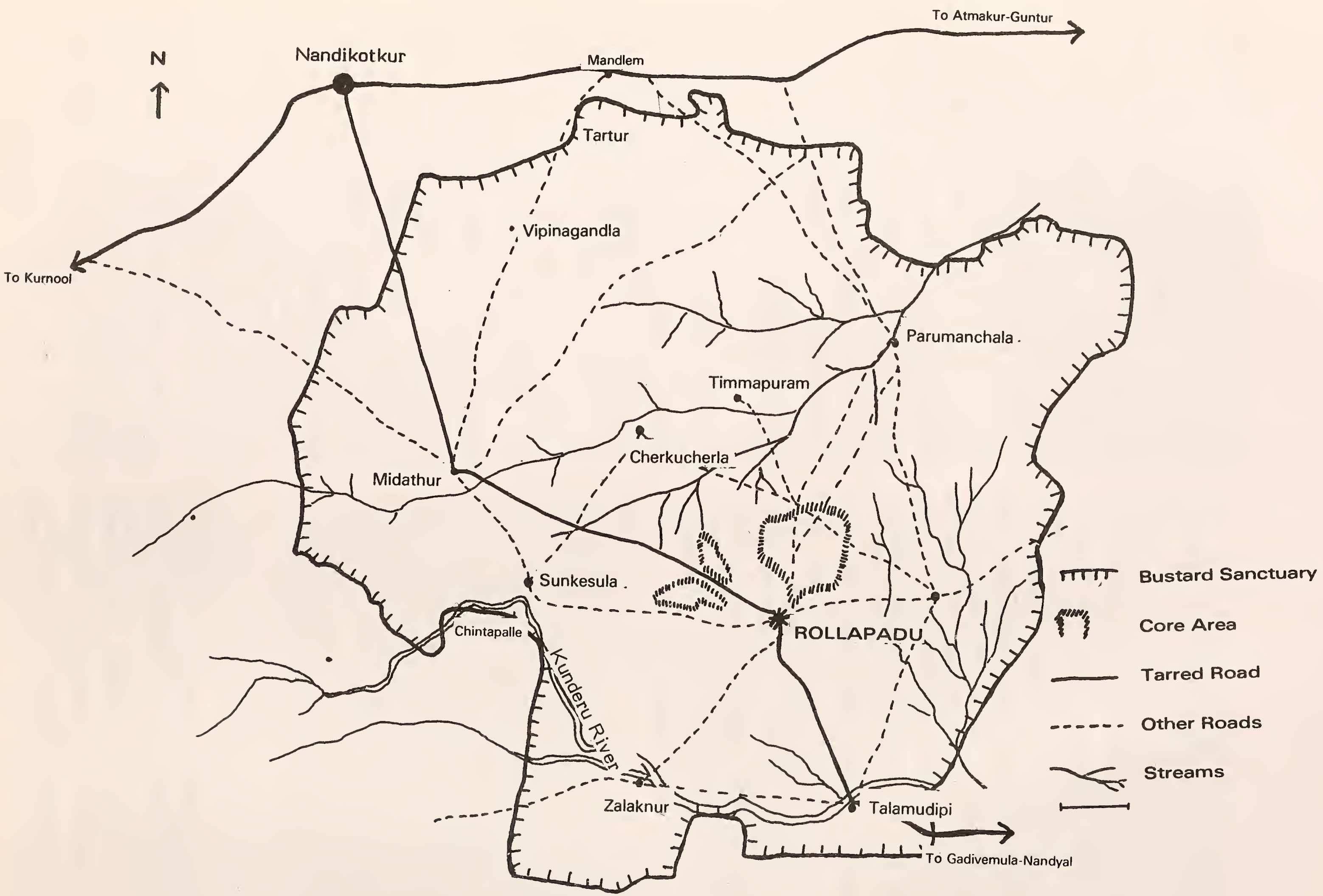
[1] Accepted August 1988.

[2] Bombay Natural History Society, Hornbill House,
Shaheed Bhagat Singh Road, Bombay–400 023.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Nandikotkur
Mandlem
To Atmakur-Guntur
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Tartur
Vipinagandla
Parumanchala
Timmapuram
Cherkucherla
Midathur
Sunkesula
ROLLAPADU
Chintapalle
Kunderu River
Zalaknur
Talamudipi
To Gadivemula-Nandyal
Bustard Sanctuary
Core Area
Tarred Road
Other Roads
Streams

Map 1. Proposed Great Indian Bustard Sanctuary in Rollapadu

### VEGETATION

The vegetation of Rollapadu is of the Tropical Thorn Forest type (Champion & Seth 1968). However, human and human-related pressures have converted the landscape to one of crop fields, grazing lands and very light scrub.

The vegetation in the enclosure may be generally termed a grassland with a few scattered shrubs and trees. The common grass species are *Aristida funiculata, Chrysopogon fulvus, Eremopogon foveolatus, Heteropogon contortus* and *Iseilema anthephoroides*. During our stay period we observed that *H. contortus* spreads to more and more areas with each passing year. For example, a favoured nesting site of the bustard which was *E. foveolatus* dominant area in 1985 was overrun by *H. contortus* by 1987. Common herbs are *Alysicarpus scariosus, Boerhavia diffusa, Cleome felina, Indigofera cordifolia, Indigofera linifolia, Justicia procoumbens, Lepidagathis cristata, Polygala chinensis* and *Rhynchosia minima*. Shrubs and trees are represented by *Butea monosperma, Cassia auriculata, Cassia fistula, Canthium parviflorum, Diospyros melanoxylon, Morinda tinctoria, Prosopis spicigera, Randia dumetorum* and *Phoenix sylvestris*.

Owing to the absence of grazing and wood cutting, the vegetation in the enclosure has improved and contrasts sharply with the surrounding grazing lands. While the grass height in the enclosure exceeds 50 cm with good ground cover, the grazing lands exhibit the typical profile of the overgrazed lands of our country with short grass and much exposed bare ground. Another interesting difference in the vegetation of the enclosure to that of the grazing lands is with regard to the grass *Sehima nervosum*. Not a single specimen of *S. nervosum* has been recorded in the grazing lands, while they have even formed pure stands in some areas of the enclosure. Dabadghoa & Shankarnarayan (1973) classified the grasslands of these parts under the *Sehima/Dichanthium* cover — if allowed to reach the climax stage by factors like absence of grazing and fires. It will be interesting to see the final climax vegetation cover in the enclosure.

Most of the plants belong to what are termed as 'monsoon ephemerals'. Life for these plants begins with the onset of the monsoon in June, changing the bare brown/yellow landscape to lush greenery. The plants grow, flower, fruit, seed, and by the first week of December almost all the plants have died.

### FAUNA

The Sanctuary, though established primarily to protect the bustard, has benefited rest of the wildlife in the area. Prior to its establishment, the animals were persecuted by professional trappers and hunters from nearby towns and villages. These activities were checked with the posting of Forest Department personnel. Poaching of the bustard, florican and blackbuck (and all wildlife that inhabit the enclosure) is almost nil, but hunting of other species especially quail, partridge, sandgrouse, duck, barheaded geese, demoiselle crane continues on the sly in the surrounding areas.

### GREAT INDIAN BUSTARD

The bustard was known to exist in the 'dry districts' of Andhra Pradesh. Hume & Marshall (1879) reported their presence in the "Nizam's territory". Elliot (1880) gave an account of falconers going in for the bustard and also stated that bags were so poor that a successful falconer was conferred with a village 'Inam' (or free tenure). Tostems (1887) saw a few bustards in the cold season in Kurnool district. Later Blanford (1898), writing on the distribution of the bustard in the Indian subcontinent, mentioned 'Hyderabad territories'. Burton (1953) gave more precise data by stating that in the 1890s, he saw 17 birds (of which 13 were in a flock) near Guntakal.

Till recently, little was known regarding the present status of the bustard in Andhra Pradesh. Pushp Kumar (1980), on the basis of information gathered from hunters and Forest Department Personnel, offered a rough estimate of 15 birds for the whole state. Then in August 1982, their presence was recorded when a few birds were sighted at Rollapadu and Banganapalle in Kurnool district. In July 1984, the largest recorded flock in recent times of 35 bustards was sighted at Rollapadu (Ali & Rahmani 1982-84). The bustard is now known to exist at Rollapadu, Banganapalle, Neliibanda, Peddapadu, Siruvella, Palakurti and Malligeli in Kurnool district; Hanimireddy-palli in Anantapur district; Chevalla and Shamshabad in Rangareddy district; and there are unconfirmed reports of their presence in some parts of Mahboobnagar district (Manakadan & Rahmani 1986).

Till the posting of watchmen at Rollapadu in August 1982, the bustard was hunted regularly by professional trappers. The shikaris put the number of birds bagged each year at about a dozen. The birds were were trapped by laying nooses at display sites, groundnut fields and waterholes–and were sold at the Nandikotkur market. The shikaris have no idea of the former population, except saying that the birds were scattered then and traps were laid when they noticed a few birds frequenting an area, unlike now, where they congregate at Rollapadu. The present population is in the range of 60-100 birds, judging by daily counts done, flock sizes seen and the number of nests located each year. An exact population estimate is not possible since the bustards move a lot and those that frequent the enclosure are mainly breeding birds.

**Movement and Flock Composition:** The movement and flock composition of the bustard depends much on the season and local weather conditions. Sexes generally remain separate and mixed flocks are rare and temporary (Rahmani & Manakadan 1986a). With the onset of the SW monsoon in early June, there is an influx and congregation of bustards in the grasslands of Rollapadu. June to August is the period when both largest numbers and largest flock sizes are seen (Tables 1 & 2). For example, in May 1986, mean group size of the males was 1, in June 4.4, in July 7.5 and 3.4 in August. Similar results were obtained in 1987, i.e. largest flocks of males were seen between June and August (except for February, when a flock of 7 and another of 4 birds were seen: but the sample size is very small (Table 1). The flocks were mainly unisexual, there being a very clear segregation of the sexes; fixed flocks are rare. For example, between June and August 1986, only one mixed flock of 3 birds (0.92%) out of 108 flocks was seen. Similarly, during the same period in 1987, only 5 (3.7%) of 132 flocks were of both sexes.

By mid-August, the major breeding season starts (Fig. 1) and soon the adult hens separate from the flocks to commence nesting. Adult cocks also form territories and become more and more solitary. Between June to August, around 50% of the sightings were of solitary birds, but from September onwards (Tables 3 & 4), these sightings increased to nearly 80%. In September 1986 (Table 3), 96.7% sightings were of solitary bustards. Non- breeding hens and cocks frequent the Rollapadu grasslands much less between September and December. For reasons still not clear, rainy days result in an influx of birds, the birds moving out again with the dry spell. The dominant cocks seem less pugnacious during rainy days and tolerate the presence of other males.

By the first week of December, the grasslands become more and more dry and only the displaying cocks and hens with chicks are seen. By January, only the territorial cocks and some late nesters are left in the enclosure area. However, bustards are seen in small droves of 2 to 7 individuals in the nearby areas. The months of February, March and the first half of April may be considered as the lull period for bustards as far as the grasslands of Rollapadu are concerned, since there is no breeding activity and the birds have moved out into the surrounding areas. However, in 1988, a few birds were present during this period also possibly due to the delayed monsoon of 1987.

By the third week of April, dust storms with scattered rains and showers occur. This weather heralds the onset of the 'minor breeding season', which extends till late May or early June. a few cocks and hens frequent the area and two or three nests are located every year (Table 5). Most sightings are of solitary birds. With the onset of the monsoon at the end of June, the cycle repeats itself.

**Breeding:** The most interesting aspect of the breeding cycle is the existence of two breeding seasons–a major and a minor–at Rollapadu, unlike only one breeding season in the other areas studied. At Nanaj in Solapur district, Maharashtra, the bustard breeds during the monsoon period, while at Karera in Shivpuri district, Madhya Pradesh, they breed during summer. At Rollapadu, the major breeding season begins around mid-August and eggs may be laid till January. The minor breeding season begins with the onset of drizzles or rains in the third week of April and the season (judging from display activity) lasts till late May or early June. The reason for the existence of two breeding seasons at Rollapadu remains unexplained as we were not allowed to ring or band the birds for our studies. We do not know whether different individuals come to breed in the two seasons or birds which were unsuccessful in one season come to breed in another.

The courtship display activity is also interesting. In the 1985 major breeding season and the 1986 minor season, only one male (Meeta Male — see Map 2) displayed. A few other males also displayed but only in the absence of the Meeta Male or when he was less pugnacious as on rainy days or for some inexplicable reasons. In the 1986 major season, the Meeta Male fought with a few other males that came to display in his territory, after which there was little display activity that season. In the following minor season of 1987, only one male displayed at the same display site.

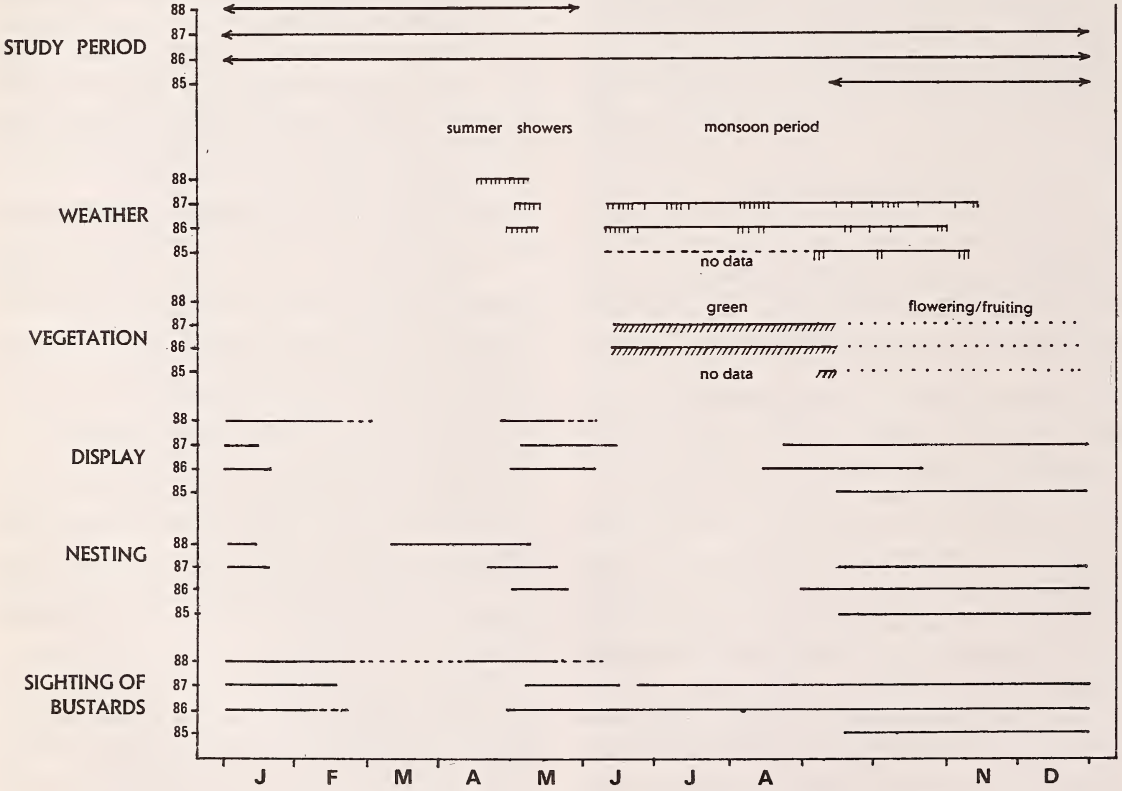


Fig. 1 Phenology of Events (September 1985-June 1988) at Rollapadu

TABLE 1

FLOCK SIZE IN DIFFERENT MONTHS IN 1986 AT ROLLAPADU

| Flock Size | January | | | February | | | March | | | April | | | May | | | June | | | July | | | August | | | Septemper | | | October | | | November | | | December | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | M | F | M1 | M | F | M1 | M | F | M1 | M | F | M1 | M | F | M1 | M | F | M1 | M | F | M1 | M | F | M1 | M | F | M1 | M | F | M1 | M | F | M1 | M | F | M1 |
| 1. | 3 | 5 | - | - | 1 | - | - | - | - | 3 | - | - | 21 | 3 | - | 5 | 1 | - | 2 | 10 | - | 9 | 17 | - | 23 | 36 | - | 36 | 48 | - | 10 | 24 | - | 18 | 36 | - |
| 2. | 1 | 3 | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | 1 | - | 4 | 4 | - | 7 | 5 | - | 1 | - | - | 2 | 4 | - | 5 | 6 | - | 3 | 3 | - |
| 3. | 1 | 3 | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | 4 | 3 | - | 4 | - | - | 1 | - | - | 1 | 1 | - | 5 | - | - | 1 | - | - |
| 4. | 3 | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 2 | - | - | 4 | - | - | - | - | - | - | - | - | 4 | - | - | 1 | - | - |
| 5. | - | - | 1 | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 2 | - | - | - | - | - | 1 | - | - | 3 | - | - | 1 | 2 | - |
| 6. | - | - | 1 | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | 1 | - | - | - | - | - | 3 | - | - | 1 | - | - | - | - | - |
| 7. | 1 | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | 3 | - | - | 1 | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - |
| 8. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 9. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 10. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 2 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 11. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 12. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 2 | - | - | 2 | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 13. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 14. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 15. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 2 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 16. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 3 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Mean group size | 3 | 1.8 | 4.6 | 5.5 | 1 | 5.5 | - | - | - | 1.2 | - | - | 1 | 1 | - | 4.4 | 1.5 | 3 | 7.5 | 1.5 | - | 3.4 | 1.2 | - | 1.1 | 1 | - | 1.5 | 1.1 | - | 2.7 | 1.2 | - | 1.5 | 1.3 | - |
| Mean group size of both sexes | 2.6 | | | 4.6 | | | 0 | | | 1.2 | | | 1 | | | 3.8 | | | 5.2 | | | 2.5 | | | 1 | | | 1.3 | | | 1.9 | | | 1.4 | | |

M = Male; F = Female; M1 = Mixed Flock.

TABLE 2

FLOCK SIZE IN DIFFERENT MONTHS IN 1987 AT ROLLAPADU

| Flock Size | January | | | February | | | March | | | April | | | May | | | June | | | July | | | August | | | Septemper | | | October | | | November | | | December | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | M | F | M1 | M | F | M1 | M | F | M1 | M | F | M1 | M | F | M1 | M | F | M1 | M | F | M1 | M | F | M1 | M | F | M1 | M | F | M1 | M | F | M1 | M | F | M1 |
| 1. | 17 | 15 | - | 4 | - | - | - | - | - | 2 | - | - | 14 | 11 | - | 14 | 3 | - | 7 | 7 | - | 10 | 4 | - | 41 | 35 | - | 85 | 40 | - | 67 | 11 | - | 68 | 10 | - |
| 2. | - | 11 | - | - | 4 | - | 2 | - | - | 3 | - | - | 2 | 4 | - | 6 | 6 | - | 2 | 5 | - | 1 | 10 | - | 1 | 4 | - | 2 | 10 | - | 2 | 7 | 1 | - | 12 | - |
| 3. | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | 1 | 1 | - | 3 | - | - | - | - | 3 | 5 | - | 1 | 5 | - | 1 | 2 | - | 1 | 1 | - |
| 4. | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | 2 | 4 | 1 | - | 3 | 4 | - | 1 | 2 | - | 1 | 2 | - | - | - | - | - | 5 | - |
| 5. | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | 4 | - | - | 2 | - | - | 3 | 1 | - | 2 | - | - | - | - | - | 2 | 1 | - | - | - | - |
| 6. | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | 1 | - | - | - | 4 | - | 1 | - | 1 | - | - | - | - | - | 1 | - | - | - |
| 7. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 3 | - | - | 1 | 1 | - | - | - | - | - | - | 1 | - | - | - | - | 1 | - |
| 8. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | 1 | - | - | 1 | 2 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 9. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | 1 | - | - | 2 | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 10. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 4 | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 11. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 12. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - |
| Mean group size | 1 | 1.8 | - | 1 | 2 | - | 2 | - | - | 1.6 | - | - | 1.1 | 1.2 | - | 2.4 | 1.8 | 4.7 | 3.8 | 1.8 | - | 4.4 | 3.7 | 12 | 1.4 | 1.3 | 6 | 1.0 | 1.4 | 7 | 1.0 | 1.7 | 4 | 1 | 2.2 | - |
| Mean group size of both sexes | 1.5 | | | 1.5 | | | 2 | | | 1.6 | | | 1.1 | | | 2.5 | | | 3 | | | 4.2 | | | 1.5 | | | 1.2 | | | 1.2 | | | 1.3 | | |

TABLE 5

NUMBER OF EGGS LAID IN DIFFERENT MONTHS*

| Year | J | F | M | A | M | J | J | A | S | O | N | D | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1985 | - | - | - | - | - | - | - | 1 | 4 | 4 | 2 | - | 2 hatched shell remains located after January 1985 |
| 1986 | - | - | - | 2 | - | - | - | 2 | 1 | 3 | 1 | 2 | - |
| 1987 | 1 | - | - | 2 | 1 | - | - | - | 6 | 6 | 3 | 3 | 2 hatched shell remains located after January 1987 |
| 1988 | 2 | - | - | 2 | - | - | - | - | - | - | - | - | - |

* Study period: August 1985 to May 1988.

TABLE 3

NUMBER OF GROUPS (n) AND PERCENTAGES (%) OF BUSTARDS IN DIFFERENT MONTHS AT ROLLAPADU – 1986

| Group | January | | February | | March | | April | | May | | June | | July | | August | | September | | October | | November | | December | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Size | n | % | n | % | n | % | n | % | n | % | n | % | n | % | n | % | n | % | n | % | n | % | n | % |
| 1. | 8 | 34.7 | 1 | 20 | - | - | 3 | 75 | 24 | 100 | 6 | 50 | 12 | 27.9 | 26 | 49 | 59 | 96.7 | 84 | 87.5 | 34 | 57.6 | 54 | 83 |
| 2. | 4 | 17.3 | - | - | - | - | 1 | 25 | - | - | 1 | 8.3 | 8 | 18.6 | 12 | 22.6 | 1 | 1.6 | 6 | 6.2 | 11 | 18.6 | 6 | 9.2 |
| 3. | 5 | 21.1 | - | - | - | - | - | - | - | - | 1 | 8.3 | 7 | 16.2 | 4 | 7.5 | 1 | 1.6 | 2 | 2 | 5 | 8.4 | 1 | 1.5 |
| 4. | 3 | 13.0 | 1 | 20 | - | - | - | - | - | - | - | - | 2 | 4.6 | 4 | 7.5 | - | - | - | - | 4 | 6.7 | 1 | 1.5 |
| 5. | 1 | 4.3 | 1 | 20 | - | - | - | - | - | - | - | - | - | - | 2 | 3.7 | - | - | 1 | 1 | 3 | 5 | 3 | 4.6 |
| 6. | 1 | 4.3 | 1 | 20 | - | - | - | - | - | - | - | - | 1 | 2.3 | 1 | 1.8 | - | - | 3 | 3.1 | 1 | 1.6 | - | - |
| 7. | 1 | 4.3 | 1 | 20 | - | - | - | - | - | - | 1 | 8.3 | 3 | 6.9 | 1 | 1.8 | - | - | - | - | 1 | 1.6 | - | - |
| 8. | - | - | - | - | - | - | - | - | - | - | 1 | 8.3 | - | - | - | - | - | - | - | - | - | - | - | - |
| 9. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | 1.8 | - | - | - | - | - | - | - | - |
| 10. | - | - | - | - | - | - | - | - | - | - | 2 | 16.6 | - | - | - | - | - | - | - | - | - | - | - | - |
| 11. | - | - | - | - | - | - | - | - | - | - | - | - | 1 | 2.3 | - | - | - | - | - | - | - | - | - | - |
| 12. | - | - | - | - | - | - | - | - | - | - | - | - | 2 | 4.6 | 2 | 3.7 | - | - | - | - | - | - | - | - |
| 13. | - | - | - | - | - | - | - | - | - | - | - | - | 1 | 2.3 | - | - | - | - | - | - | - | - | - | - |
| 14 | - | - | - | - | - | - | - | - | - | - | - | - | 1 | 2.3 | - | - | - | - | - | - | - | - | - | - |
| 15. | - | - | - | - | - | - | - | - | - | - | - | - | 2 | 4.6 | - | - | - | - | - | - | - | - | - | - |
| 16. | - | - | - | - | - | - | - | - | - | - | - | - | 3 | 6.9 | - | - | - | - | - | - | - | - | - | - |

TABLE 4

NUMBER OF GROUPS (n) AND PERCENTAGES (%) OF BUSTARDS IN DIFFERENT MONTHS AT ROLLAPADU — 1987

| Group | January | | February | | March | | April | | May | | June | | July | | August | | September | | October | | November | | December | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Size | n | % | n | % | n | % | n | % | n | % | n | % | n | % | n | % | n | % | n | % | n | % | n | % |
| 1. | 32 | 68 | 4 | 50 | - | - | 2 | 40 | 25 | 80.6 | 17 | 47.2 | 14 | 37.8 | 14 | 26.4 | 76 | 79.1 | 125 | 85 | 78 | 82.1 | 78 | 79.5 |
| 2. | 11 | 23.4 | 4 | 50 | 2 | 100 | 3 | 60 | 6 | 19.3 | 6 | 16.6 | 7 | 18.9 | 11 | 20.7 | 5 | 5.2 | 12 | 8.1 | 10 | 10.5 | 12 | 12.2 |
| 3. | 1 | 2.12 | - | - | - | - | - | - | - | - | 3 | 8.3 | 3 | 8.1 | - | - | 8 | 8.3 | 6 | 4.0 | 3 | 3.1 | 2 | 2.0 |
| 4. | 1 | 2.12 | - | - | - | - | - | - | - | - | 3 | 8.3 | 5 | 13.5 | 7 | 13.2 | 3 | 3.1 | 3 | 2 | - | - | 5 | 5.1 |
| 5. | 1 | 2.12 | - | - | - | - | - | - | - | - | 4 | 11.1 | 2 | 5.4 | 4 | 7.5 | 2 | 2.0 | - | - | 3 | 3.1 | - | - |
| 6. | 1 | 2.12 | - | - | - | - | - | - | - | - | 1 | 2.7 | 1 | 2.7 | 4 | 7.5 | 2 | 2.0 | - | - | 1 | 1.0 | - | - |
| 7. | - | - | - | - | - | - | - | - | - | - | - | - | 3 | 8.1 | 2 | 3.7 | - | - | 1 | 0.6 | - | - | 1 | 1.0 |
| 8. | - | - | - | - | - | - | - | - | - | - | 1 | 2.7 | 1 | 2.7 | 3 | 5.6 | - | - | - | - | - | - | - | - |
| 9. | - | - | - | - | - | - | - | - | - | - | 1 | 2.7 | 1 | 2.7 | 2 | 3.7 | - | - | - | - | - | - | - | - |
| 10. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 5 | 9.4 | - | - | - | - | - | - | - | - |
| 12. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | 1.8 | - | - | - | - | - | - | - | - |

Since we worked with unbanded birds, we could not identify individual birds.

Initially, we presumed that the cock that frequented and displayed at the same site had to be the same bird, but *shikaris* told us that it was their experience that it need not necessarily be so. They say that the site where Meeta Male displays has been a traditional display spot for years and as soon as a displaying cock was caught another would replace him within a day or two. In one season about 8 years ago, they were able to noose and trap 5 displaying cocks from the same spot, one subsequently replacing the other. Hence, we are not certain if the cock termed Meeta Male by us, was the same bird throughout the season/seasons.

In the 1987 major season, two other males (Taggu and Bailpadu cocks — see Map 2) established territories in other areas in the enclosure, all three being separated by about half kilometre from each other. Adding to the confusion, only the Meeta Male displayed in the following minor season (1988). Bailpadu Male displayed for only two days. A male frequented the Taggu area for some days but no display activity was noticed. The pattern of display activity is confusing. Four or five years of studies on banded birds may give a clearer picture of the territoriality of the bustard.

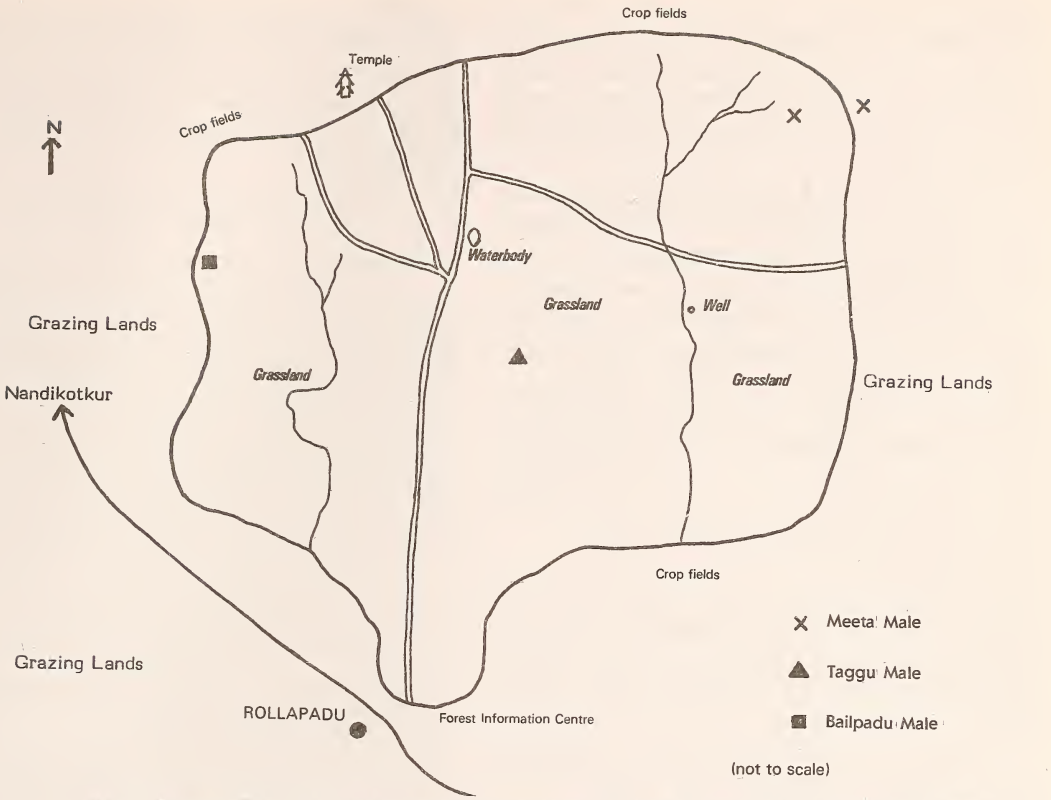
**Lesser Florican:** *Nela Nemali* (ground peacock) or the lesser florican *Sypheotides indica* is known to *shikaris* in these parts. An old trapper reports that till the severe cyclone that hit the Andhra coast in the summer of 1977–the resultant downpours around Rollapadu were reported to have killed a lot of wildlife–the florican was occasionally seen and one or two displaying cocks were caught every year. Another *shikari* reported seeing a nest once. After that, there were no more further sightings till a few years ago, when a trapper saw a displaying cock in groundnut fields around Nandikotkur.

For the first two years of our study period, we flushed floricans on one or two occasions each year, but did not see any displaying cocks or cocks in breeding plumage, and presumed that the florican did not breed here inspite of the earlier accounts of *shikaris*. The general belief about the florican was that their major breeding grounds are in Gujarat and Madhya Pradesh and the birds 'wintered' in the peninsular inspite of the existence of some breeding records for South India (Jerdon 1864, Ali & Ripley 1969). However, on 10 October 1987, we came across a cock displaying in the enclosure. Display was seen again on 29 October, during which another cock was noted, but further displays stopped abruptly. About the same time, reports of two displaying floricans at about 5 km southeast of Nandikotkur were received and later, on 27 November, a nest was located in a groundnut field. Then, there was a lull in florican activities till 2 January 1988, when a nest was located in the enclosure, and three males started almost daily morning displays till about the end of January. Another nest was also located during this period. Added to these cases, a nest with two chicks was found 23 km west of Rollapadu and then came reports of two nests at Banganapalle. And finally, a month old chick was picked up by a villager a kilometre south of Rollapadu on 27 February 1988.

What caused the sudden spate of florican breeding activity at Rollapadu and the other areas in 1987? Perhaps it was the failure of rains in their main strongholds in Gujarat and Madhya Pradesh (where breeding was not reported that year) which causes the birds to migrate here to breed. However, for birds whose breeding cycle is so intrinsically tied to the monsoon rains, the possibility of a population breeding during the NE monsoon in South India cannot be discounted. As suggested for the bustard, more studies on a long term basis with banded birds will answer these questions.

**Demoiselle Crane:** Flocks of up to a thousand Demoiselle Cranes *Anthropoides virgo* may be seen in winter. Their arrival reaches a peak in January and February, during which they cause havoc to the sorghum crop. Farmers consider them a pest and there are frequent complaints to the Forest Department regarding crop losses and requests for compensation.

In the winter of 1987/88, there was an unusually large influx of cranes, probably due to the


Crop fields
Temple
N
Crop fields
Waterbody
Grassland
Well
Grazing Lands
Nandikotkur
Grassland
Grassland
Grazing Lands
Crop fields
× Meeta Male
▲ Taggu Male
■ Bailpadu Male
Grazing Lands
ROLLAPADU
Forest Information Centre
(not to scale)

**Map 2. Enlarged view of the 800-acre enclosure near Rollapadu showing the display spots**

drought in Gujarat. *Shikaris*, to whom the crane is a prized bird since each can fetch 50 rupees, put the numbers arriving each season at less than 5,000 but say it exceeded 10,000 birds for 1987/88. They put the numbers trapped each year at about 150-200 birds.

**Barheaded Goose:** The Barheaded Goose *Anser indicus* is reported to be a regular winter visitor to these areas. The goose is also a much sought after species by *shikaris*. In the winter of 1985/86, we saw flocks of about 200-300 geese and up to 500 in 1986/87, but in 1987/88 there was a drastic decline with not more than 32 being seen at a time.

**White Stork:** The White Stork *Ciconia ciconia* is reported to be a regular winter visitor. *Shikaris* mention that flocks of 50-100 are not uncommon. The largest flock size we saw, was 26 birds in January 1988. In the winter of 1985-86, we saw only two birds.

**Black Stork:** The southernmost record for the Black Stork *Ciconia nigra* in India was Solapur district (*c.* 18°N) in the state of Maharashtra (Ali & Ripley 1969). However, we saw this stork during every winter at Rollapadu (c. 15°N). The maximum flock size seen was 6 birds in 1985, the other sightings consisted of one, two or three individuals at a time. The storks were mainly seen around November-December (Manakadan 1987).

**Harriers:** Rollapadu harbours the largest reported wintering population of harriers in India (Rahmani & Manakadan 1986b). Most common is the Montagu's Harrier *Circus pygargus*, followed by the Pale Harrier *Circus macrourus*. The Pied Harrier *Circus melanoleucos* has been recorded on three occasions. The harriers number about a thousand during the peak period.

**Blackbuck:** On arrival in September 1985, we estimated the blackbuck *Antilope cervicapra* population at about 17 individuals: 3 adult males, 2 subadult males and 12 females. By the end of our studies in May 1988, their population had risen to 35-40.

It will be interesting to note their population in another 5 or 10 years and see whether the blackbuck will pose problems as it does in the Karera Bustard Sanctuary. In Karera, the blackbuck population of about 50-60 animals in 1982 has increased to more than 600 (in 1988) and is a nuisance to farmers due to their crop damage. Villagers say that there used to be more blackbuck at Rollapadu earlier and hunters would come from nearby villages and towns to hunt them. Now, with total protection, the situation will probably end up as in the Karera Bustard Sanctuary.

**Wolf:** Sightings of the wolf *Canis lupus* are not uncommon at Rollapadu. The largest pack size recorded was 3, but usually only a pair was seen. Breeding was recorded in the enclosure in January/February of 1985, 1986, 1987 but not in 1988.

We have no idea of the population of the wolf in the Sanctuary. As stated earlier, usually a pair was seen and breeding was recorded almost every year. What happens to the young ones reared each year (since we continued to see only a pair)? The presence of wolves is known to all the villagers in these parts. Does it indicate a good population or is it due to movement by a few individuals, and hence sightings of same individuals in different places? The pair at Rollapadu may be seen daily for a few days/ weeks in the enclosure and at other times be missing for long periods. Only radio-collaring a few wolves and studying their movement for a few years will tell us the true status of wolves around Rollapadu.

**Fox:** Not more than a pair of fox *Vulpes bengalensis* was seen in the enclosure. This species appears to be uncommon in the Rollapadu grasslands.

**Jungle Cat:** We had no actual sightings of any felines but the presence of *Jungan Billi* is known to the locals. A few have been reported killed while raiding chicken coops. Two species of cats are said to be present. One is grey with a short tail, which tallies to the description of jungle cat *Felis chaus*. The other is said to be bigger than the jungle cat and with a coat similar to that of the leopard cat *Felis bengalensis*. Its identity needs confirmation.

## DISCUSSION AND RECOMMENDATIONS

The Rollapadu Wildlife Sanctuary with an area of 614 ha. is probably the smallest wildlife sanctuary of our country. Even this expanse of 614 ha. is not in one block, but divided into three portions of varying sizes separated by crop fields and grazing lands. The bustards are not confined to only these 614 ha. but move around in a large area, and as we have described earlier, the bustards come to the grasslands of Rollapadu mainly for breeding. Except during the three or four months of the monsoon, a greater population of the bustards at any given time is present outside the Rollapadu area and therefore, protection of the surrounding areas is important. Unfortunately, we do not have data on colour-marked or radio-collared birds, so we do not know how far the birds move. Due to this lacunae in our knowledge about the bustard, it becomes more important to protect as large a buffer zone as possible.

At present, the areas surrounding the Rollapadu grasslands are still suitable for bustards being marginally cultivated and/or used for livestock grazing. However, the situation in 3 or 4 decades may not remain the same. With the growing human population and the resultant hunger for land, disturbances due to increase in agriculture, livestock population and other human and human-related factors are bound to multiply. A large sanctuary could lessen the shocks of disturbances at its borders, but can a 614 ha. sanctuary withstand this?

It is necessary to include the surrounding bustard frequented areas as a buffer zone. The buffer zone should officially be included into the sanctuary plans so that the Forest Department can have some control in the land use pattern and any major development detrimental to the bustard could be avoided. Elsewhere, we have described the importance of a large buffer zone in a bustard sanctuary (see Rahmani & Manakadan 1988). Some states like Madhya Pradesh, Rajasthan and Maharashtra have set up bustard sanctuaries with large buffer zones of a few hundred square kilometres and core areas of 100-200 ha. Traditional agriculture and livestock grazing is allowed in the buffer zones, while the core areas are protected from all interferences during the breeding season.

We suggest that the Andhra Pradesh Forest Department demarcate at least 200 sq. km around Rollapadu grasslands as the buffer zone and strict monitoring of the changes in the traditional land use should be coordinated with other government departments. In fact, the original plan of the Forest Department was to have 614 ha. as the core area of the Sanctuary with the surrounding areas as the buffer zone (see Map 1), but unfortunately, the plan was changed. We hope rethinking is done on this issue and more core areas and a buffer zone are added into the Sanctuary.

Lastly, mention must be made about the other bustard areas of Andhra Pradesh. Unfortunately, the protection and conservation measures taken at Rollapadu are not being carried out in the other bustard areas. At Banganapalle, other than the posting of a watchman, no habitat conservation measures have been taken — the bustard lives in crop fields, private lands and overgrazed grasslands. At Hanimireddy-palli in Anantapur district, the plot is overgrazed since the purpose of the plot was afforestation, and not much attention is being paid to the bustard inspite of its endangered status. In all the other areas, i.e. Nellibanda, Peddapadu, Siruvella, Palakurti, Malligeli, Chevalla and Shamshabad where the bustard is known to exist, no protection measures like posting of Forest Department personnel, leave alone habitat conservation, has been undertaken.

We have no idea of the status of the bustard in these areas. No information is available regarding the population of the birds, the trend of the population (whether on the decline or increasing in numbers), breeding records, etc. Their population is probably on the decline with poaching and habitat destruction. The Forest Department should not be content with the success at Rollapadu. The other bustard areas need urgent attention otherwise it will be too late to save them. Posting of watchmen, development of grassland plots, effective protection against poaching and illegal grazing, and generating local support by necessary publicity should be started by in all the important bustard areas.

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# STATUS, DISTRIBUTION AND GENERAL ECOLOGY OF THE INDIAN PYTHON *PYTHON MOLURUS MOLURUS* LINN. IN KEOLADEO NATIONAL PARK, BHARATPUR, RAJASTHAN, [1]

S. BHUPATHY AND V.S. VIJAYAN[2]

(*With a plate and two text-figures*)

## INTRODUCTION

The Indian subcontinent has two species of python (Family: Boidae), namely Reticulated Python *Python reticulatus* and Rock Python *P. molurus*. The latter has two races: *P.m. molurus* and *P.m. bivittatus*, which are popularly known as the Indian and the Burmese python respectively. The Indian Python is recorded in, Pakistan, Nepal, Bangladesh and Sri Lanka, apart from India. Probably because of the deep-rooted superstitions about snakes and their cryptic nature, most of them have not been studied in detail in the subcontinent. The Indian Python is no exception. Reliable information on the population, habitat and ecology of this giant snake is not available, although notes on its distribution, food and general biology are available (Smith 1943, Pope 1962, Minton and Minton 1973, Sharma and Sharma 1977, Whitaker 1978, Daniel 1983). However, a considerable amount of work has been carried out in captivity on its breeding (Acharjyo and Misra 1976, Van Mierop and Bernard 1978, Dattatri 1983), growth rate (Acharjyo and Misra 1980) and parasites (Pope 1962, Frank and Haefner 1981, Ismail 1984). The present paper deals with the population, distribution and habitats, cohabiting animals, predation, ectoparasites, breeding season, hibernation, and aestivation of the Indian Python.

The study was conducted in the Keoladeo National Park, Bharatpur (27° 7.6' to 27° 12.2' N and 77° 29.5' to 77° 33.9' E), situated 50 km west of Agra. The total area of the park is 29 sq. km, of which 8.5 sq. km is aquatic. Terrestrial vegetation is closer to the Babul Forest described by Champion and Seth (1968) under the northern dry mixed deciduous forest. A detailed account of the physical environs, flora and fauna of the Park is given by Ali and Vijayan (1983, 1986) and Vijayan (1987).

## METHODOLOGY

A complete survey was made on foot and the locations where pythons and their signs were noticed were marked on a map. The holes where pythons were seen regularly are referred to as "python points" in this study. An estimation of their population was made by checking these points repeatedly and counting the number of snakes, especially in winter when the python comes out for basking. Censuses were conducted between 0900 hrs and 1600 hrs. Approximate length of each snake, and wounds and ticks, if any, on each individual were recorded. A python between 80-120 cm in length was considered to be a young one. The maximum number of snakes recorded at a python point was taken as the population of that particular point; the total population was obtained by summing up figures obtained from each point. The method, however, has the following limitations:

1) hibernating or partially hibernating individuals in the area, if any, may escape counting,

2) foraging pythons or those which are away from the points may be overlooked,

3) young pythons are difficult to locate as they merge well with the surroundings,

4) movement of pythons from one point to the other may lead to overlap in counting. To over-

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come this last difficulty points close to each other were covered in succession.

The composition of vegetation and the cover offered by it within a 10 m radius of 39 python points was studied thoroughly. The comparative thickness of cover offered by each species of plant was ranked from 0-10. Signs of other animals in and around the python points were recorded and night observations were made to confirm the movement of animals in and out of python holes. The study was conducted between November 1985 and May 1987.

## RESULTS AND DISCUSSION

**Populations:** The maximum number of pythons recorded in the Park during the winters of 1985-86 and 1986-87 was 144 and 111 respectively (Table 1). However, 10 snakes were found dead during the former winter; the population in that period would therefore be 134. Similarly, five snakes were found dead during the winter of 1986-87 and, two python points with six pythons were found totally destroyed. These points appeared to have been dug out by people, and the fate of those six snakes was uncertain. Altogether, 21 snakes disappeared within two years.

The maximum number of snakes seen in the surveys covering the adjacent points and blocks at a stretch was 78 (Table 2). The exact number of snakes added to the population was not known. Freshly hatched egg-shells were seen in July-August 1986.

**Mortality:** Trampling by ungulates and unsuccessful attacks on porcupines may be some of the reasons for the mortality among pythons. Of 15 dead snakes recorded, 8 had hoof marks, and 2 had several small holes, presumably left by porcupine quills. Both hoof and quill marks were also seen on live snakes.

**Distribution:** Altogether, 46 python points were identified inside the Park, 41 on land and 5 in water (Fig. 1). The distribution of python points

TABLE 1

POPULATION OF PYTHONS IN EACH BLOCK DURING THE WINTERS OF 1985-86 AND 1986-87

| Block | No. of python points | Total No. of python seen | |
|---|---|---|---|
| | | 1985-86 | 1986-87 |
| A | 5 | 9 | 11 |
| B | 5 | 16 | 15 |
| C | 2 | 15 | 13 |
| F | 4 | 13 | 20 |
| G | 1 | 4 | 3 |
| H* | 4 | 7 | 2 |
| I | 5 | 30 | 15 |
| J | 1 | - | - |
| K | 3 | 8 | 14 |
| M* | 4 | 19 | 6 |
| N | 1 | 1 | - |
| O | 6 | 15 | 6 |
| Aquatic area | 5 | 7 | 6 |
| **Total** | **46** | **144** | **111** |

*One point dug out in each during early 1987 (anthrapogenic disturbance).

TABLE 2
TOTAL NUMBER OF PYTHONS SEEN IN EACH BLOCK DURING 1986-87 WINTER

| Trial | Block | No. of points | Number of snakes seen<br>Sum of the maximum of each point | <br>Counted from adjacent points at a stretch |
|---|---|---|---|---|
| I | A | 5 | 11 | 7 |
| | B | 5 | 15 | 8 |
| | O | 6 | 6 | 3 |
| | C | 2 | 13 | 11 |
| II | F | 4 | 20 | 16 |
| | I | 5 | 15 | 10 |
| III | G | 1 | 3 | 3 |
| | H | 4 | 2 | 2 |
| IV | K | 3 | 14 | 8 |
| V | M | 4 | 6 | 5 |
| VI | Aquatic area | 5 | 6 | 5 |
| **Total** | | 44 | 111 | 78 |

TABLE 3
NUMBER OF PYTHON POINTS OCCURRING AT VARIOUS DEGREES OF VEGETATION COVER

| Plant species | Percentage cover<br>10 | <br>20 | <br>30 | <br>40 | <br>50 | <br>60 | <br>70 | <br>80 | <br>90 | <br>100 | Total No. of pythons points |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *Salvadora persica* | 0 | 0 | 1 | 0 | 4 | 3 | 3 | 9 | 7 | 2 | 29 |
| *S. oleoides* | 3 | 0 | 0 | 1 | 4 | 1 | 2 | 1 | 1 | 0 | 13 |
| *Prosopis juliflora* | 8 | 7 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 18 |
| *Acacia nilotica* | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 |
| *Capparis sepiaria* | 15 | 1 | 1 | 3 | 2 | 0 | 0 | 1 | 1 | 0 | 24 |
| Others | 5 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 7 |

Note: The total number of points studied was 39.

on land was dependent mainly upon the availability of either fresh or abandoned porcupine burrows and saline patches. But in marshy areas they preferred hollow trees and termite mounds. More points were recorded in blocks F and I (9), O (6) and B (5).

The maximum number of snakes seen at one time at a particular point was 12. More than 5 snakes (Plate 1) were seen at 10 different points in both years. Block I had the maximum number

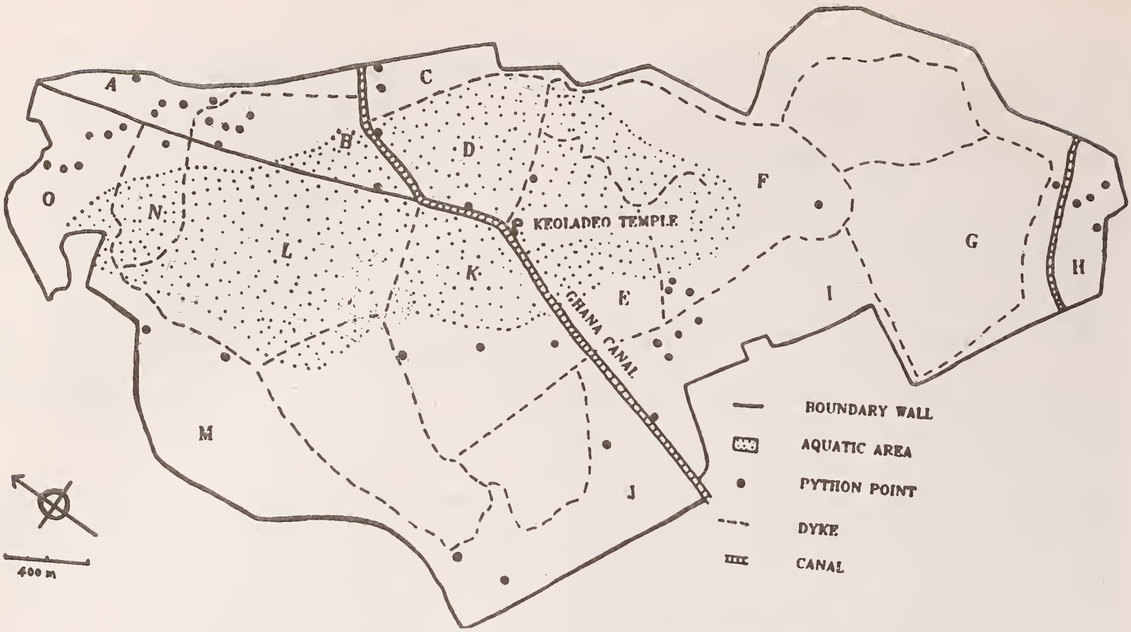


Fig. 1. Distribution of python points in Keoladeo National Park.

of snakes (30), during 1985-86 and F (20) during 1986-87 winter (Fig. 1).

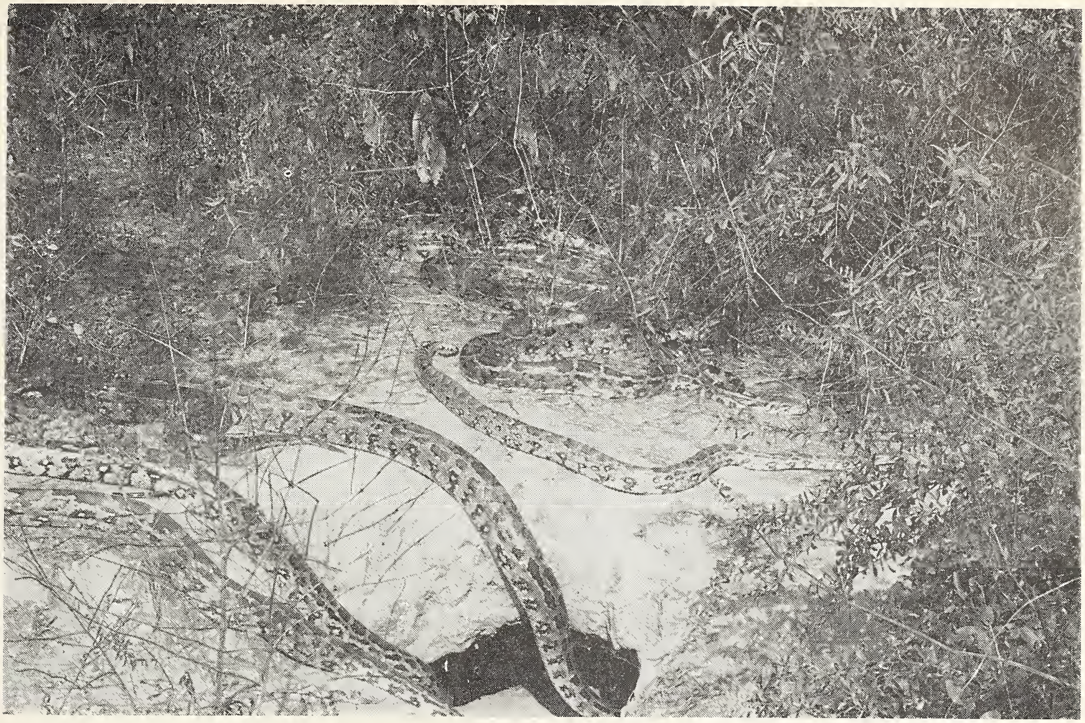
**Habitat:** Pythons usually preferred saline patches where porcupine burrows were common. Most of the burrows (83%) were situated at slightly elevated areas. The apparent advantages of the selection of such sites are: 1) the soil is comparatively loose in these areas, making it easy for the porcupine to dig, 2) elevation of the site ensures the hole against inundation during the monsoon.

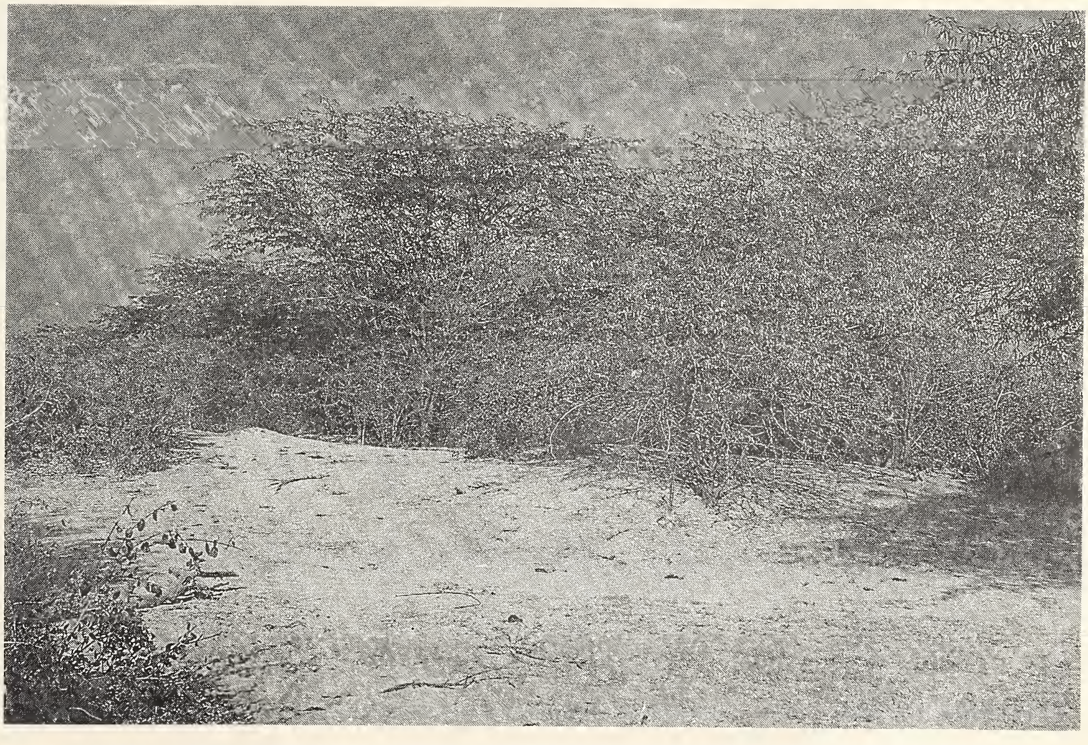
**Vegetation in python habitats:** Vegetation in the python point areas consists mainly of *Salvadora persica*, *S. oleoides*, *Capparis sepiaria*, *Prosopis juliflora* and *Acacia nilotica*. Of these, *S. persica* was the most common, followed by *C. sepiaria* (Table 3). In all but two cases, either of the *Salvadora* spp. was noticed. Pythons were seldom seen in woodlands of *Mitragyna parvifolia* and open grasslands, the latter dominated by *Vetiveria zizanioides* and *Desmostachia bipinnata*. No permanent points were recorded from these habitats.

**Vegetation cover over the python points:** The maximum cover was provided by the *Salvadora* spp. In the 39 python points studied, *S. persica* was seen in 29, and offered more than 50% of cover in 28 points. Although species such as *P. juliflora* and *C. sepiaria* were seen in many points, the cover offered by them was very low (Fig. 2).

When the foliage cover of all 39 points was considered together, it was found that 55.6% of the total cover was formed by *Salvadora persica*, 16.4% by *S. oleoides*, 8.5% by *P. juliflora*, 15.1% by *Capparis sepiaria*, 1.5% by *Acacia nilotica* and the rest by others (Fig. 2). The high preference for *Salvadora* spp. may be because of its dense foliage, which might help in cooling the burrows during the hot summer.

**Food:** Birds and mammals were the main food of the pythons in this Park, as has been reported elsewhere (Smith 1943, Minton and Minton 1973, Whitaker 1978, Daniel 1983). The following prey have been recorded from the Park: Spotbill Duck *Anas poecilorhyncha* (Sridharan and Ram Manohar 1984), Purple Moorhen *Porphyrio porphyrio* (Lalitha Vijayan and Prasad, pers. comm.), Coucal *Centropus sinensis* (Dubey 1985), Cotton Teal *Nettapus coromandelianus*, Grey Partridge *Francolinus pondicerianus*, and Redstart *Phoenicurus ochruros*; Five-striped Palm Squirrel *Funambulus pennanti*, Rufoustailed Hare *Lepus nigricollis*, and Chital *Cervus axis*. A python with porcupine quills protruding from its





*Above*: Pythons basking near their hole. *Salvadora persica,* the main cover species, is also seen.
*Below*: Typical habitat in study area.

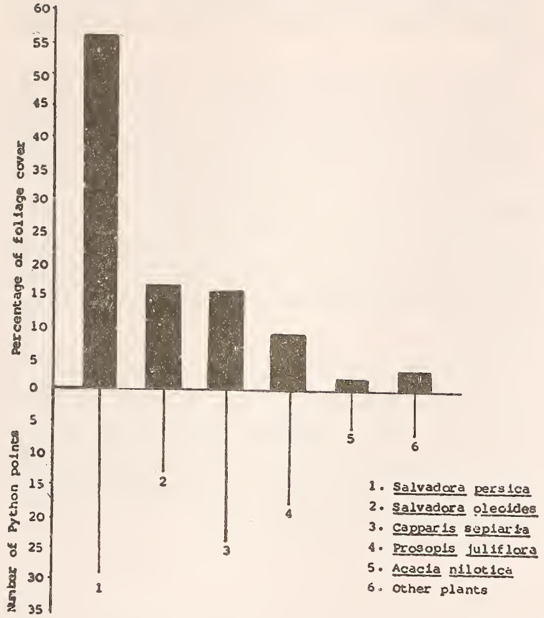


**Fig. 2. Frequency of python points under each plant species and average foliage cover.**

body has been observed by Rajan Mathur (pers. comm.).

**Co-existing species:** The Indian Porcupine *Hystrix indica* and Bicoloured Leaf-nosed Bat *Hipposideorus fulvus* were seen in the same burrow with pythons (Bhupathy and Haque 1986). During the period of this study, the Whitebreasted Kingfisher *Halocyon smyrnensis* was seen nesting successfully at the entrance of python holes.

All the python points, except those in the aquatic area, were either fresh or abandoned burrows of porcupine; quills, droppings and spoors of porcupine were present in the excavated soil, Porcupines were sighted in these holes at night. The Bicoloured Leaf-nosed Bats were seen in 21 points (51.1%) along with python and porcupine. The Whitebreasted Kingfisher nested successfully during May-September 1986 at three different points. A jackal *Canis aureus* entered a python hole thrice in January 1986, possibly as a part of den-selection for parturition. Besides this, tracks and droppings of the Striped Hyena *Hyena hyena* were seen regularly at the entrance of several python holes. Whether the hyena was preying on the python was not certain, although the phenomenon has been reported from Africa (Minton and Minton 1973).

It is interesting to note that porcupines, which at times become the prey of pythons, share the same hole with them. This may be because the hole is too cramped for the python to catch, constrict and swallow the prey.

**Predation:** It is not certain whether there is any true predator to an adult python. However, jackals in a pack of three individuals were observed attacking a python. Further, python scales were recorded in the droppings of jackal once during this study. Whether jackals feed on live snakes or scavenge is not clear. On the other hand, jackals have been recorded as a food of the python (Whitaker 1978, Daniel 1983, Singh 1983). Common Monitor *Varanus bengalensis* was observed pilfering eggs from a python hole which had both hatched and unhatched eggs. Larger eagles such as *Aquila* spp. visit the Park every year during the winter and the possibility of their preying on the young pythons cannot be ruled out.

**Ectoparasites:** Four genera of ticks, namely *Aponomma* sp., *Amblyomma* sp., *Hyalomma* sp. and *Haemophysallis* sp. have been recorded during the study. The first two have been reported earlier from captive pythons (Pope 1962, Ismail 1984).

**Breeding season:** The breeding season of the python inside the Park starts from the middle of February and extends upto the beginning of August. Frequency of mating and interhole movement was higher between February and March. Freshly-hatched egg-shells and young were seen in end July. In the Indus valley the season is almost the same (Minton and Minton 1973). Mating of pythons has also been recorded during December to March (Smith 1943, Daniel 1983). In captivity it has been reported from February to early April (Dattatri *in press*).

**Hibernation and aestivation:** Although pythons are said to hibernate in north India during winter (Smith 1943, Daniel 1983), it is doubtful that they do so inside the park. Many of them were seen basking outside their holes throughout the winter. Sloughing and feeding were also recorded during this season.

Sightings of pythons, their tracks and droppings were very few during summer, perhaps because of aestivation. Since it is the season for egg laying and incubation, only those belonging to certain age groups might be aestivating. Further detailed study using telemetric equipment is required to establish these and various other aspects of its biology.

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# POPULATION DYNAMICS OF ASSASSIN BUGS FROM PENINSULAR INDIA (INSECTA–HETEROPTERA–REDUVIIDAE)[1]

DUNSTON P. AMBROSE[2] AND DAVID LIVINGSTONE[3]

(*With four text-figures*)

Data on the population dynamics of *Acanthaspis pedestris* Stal and *Ectomocoris tibialis* Distant from Chandrapuram, a semi-arid zone. *A. pedestris* from Maruthamalai scrub jungles and *Lophocephala guerini* Laporte from Walayar, a tropical rain forest, were collected for a period of two years and analysed. Population dynamics of sixteen species belonging to four sub-families attracted to light in a typical agroecosystem in Coimbatore was also studied. In all the conditions of collection, the influence of meteorological factors on the population density of these bugs appeared to be negligible. The reduviid population fluctuations have a direct correlation to the prey population fluctuation in the semi-arid zones and scrub jungles. These studies indicate that *L. guerini* is bivoltine whereas others are either univoltine (*E. tibialis*) or multivoltine ( *A. pedestris*).

## INTRODUCTION

Assassin bugs are efficient predators, except for one species, namely *Lophocephala guerini* Laporte, and many of them are predating on insect pests. By virtue of their trophic status and their potential to regulate population of other insects, especially the insect pests, assassin bugs play an important role in both community ecology and pest control. This prompted us to investigate the population dynamics of these bugs. The present paper reports on the population dynamics of tropical rainforest, coprophagous, myrmecophiline *L. guerini* and two scrub jungle and semi-arid zone predaceous assassin bugs, namely *Acanthaspis pedestris* Stal and *Ectomocoris tibialis* Distant, and sixteen species of light-attracted assasin bugs (all predaceous) in an agrosystem.

Meteorological factors do not significantly influence the population density of these bugs, but predaceous reduviid population fluctuations have a direct correlation to the prey population fluctuations in the semi-arid zone and scrub jungles.

## MATERIAL AND METHODS

Six individual microhabitats were selected at random from Chandrapuram semi-arid zone, Maruthamalai scrub jungle in Tamil Nadu and Walayar tropical rain forest at the Tamil Nadu-Kerala border. In microhabitats, assassin bugs were counted (*A. pedestris* and *E. tibialis* in Chandrapuram, *A. pedestris* in Maruthamalai and *L. guerini* in Walayar) underneath 25 to 30 stones, which form a single observation unit. Fortnightly collection records of the population of males, females as well as nymphal instars were maintained and meteorological recordings were registered simultaneously over a period of two years. The camouflaging behaviour of *A. pedestris* presented considerable difficulty in assessing their population in the field and they were therefore not taken into account.

In Maruthamalai and Chandrapuram the approximate density of population of camponotine ants in the respective habitats was also taken into account concurrently, since these ants form the staple food of *A. pedestris* and *E. tibialis*. In the Walayar tropical rain forest the population of various nymphal instars of *L. guerini* could be readily recorded more precisely due to their contrasting coloration among the life stages. The

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nymphs have dark violaceous black dorsal abdominal bands of different lengths for different stages. Since *L. guerini* is a myrmecophiline assassin bug, the appropriate population level of the formicine ant *Anoplolepis longipes* Jerdon was also taken into consideration. In order to appreciate the restricted distribution of these bugs underneath the stones within an area less than 100 sq. m, an area of nearly 6 sq. km adjacent to the microhabitat was intensively surveyed.

In order to establish a possible migratory phenomenon observed in *A. pedestris* and *E. tibialis*, marking experiments were carried out at regular intervals (with both Indian ink & Camlin white ink). A light trap was set up in a typical agroecosystem at Coimbatore to find out the population dynamics of light attracted reduviids. The light trap collections were examined each morning and records were maintained systematically.

## RESULTS

**Chandrapuram semi-arid zone;** As far as the two predaceous assassin bugs, namely *A. pedestris* and *E. tibialis* of the semi-arid zone are concerned, the level of population in one area is by and large regulated by the density of population of camponotine ants in that area. Even though a marked decline in population was recorded following high humidity and rainfall, it was observed that physical factors such as temperature, humidity and rainfall have apparently no effect on the level of population of the two assassin bugs (Fig. 1).

In Chandrapuram the peak population was recorded in July 1977. In 1978, too, from June to August both the species recorded a similar peak. This suggests that the peak population of these two species remains constant during June-August, when the meteorological conditions are moderate. Significantly, the camponotine ant (prey) population too registered a high peak during this period. A sharp decline in the population during October-November is significant. Correspondingly, there was a sharp fall in the camponotine population, but a steep rise in relative humidity following heavy rain causing flooding of microhabitats. These observations suggest that the paucity of camponotine ants was indirectly correlated to the depletion of the predating reduviid populations both equally affected by climatic adversities. The predominance of females in almost all the collection is significant, suggesting that the field population of these reduviids is female biased.

**Maruthamalai Scrub Jungle:** In Maruthamalai, *A. pedestris* registered a brief rise during November and December 1976; the highest peak was recorded in September 1977. During the months of March, June and December in 1977 and May, June, November and December in 1978, the population was found to be at its lowest ebb. Nevertheless, it is found that there is no direct correlation between any of the meteorological factors and the population level of these bugs in this scrub jungle habitat. As in the semi-arid zone, the field population here too is apparently female biased and on only one occasion (September 1977), when the camponotine ant population was normally high, was the sex ratio found to be equal. Here too, the fall in the level of reduviid population corresponds to the depletion of camponotine ant population (Fig. 2).

**Walayar tropical rain forests.:** In April, when there was a steady rise in temperature and humidity, the sex ratio of *Lophocephala guerinii* was found to be almost equal (though female-biased). In the following months a decrease in temperature and an increase in relative humidity bring about a steep rise in the population of first instar nymphs and a significant dip in the female population. In January, when the temperature was relatively low, there was high percentage of female population, almost double that of males and the population of first instar nymphs remained high. In 1977 January, however, due to inexperience in nymph detection the data were not accurately kept. In other months, the population appeared erratic as far as the sex ratio was concerned. April 1977 registered a high population of both fifth instars and adults and the sex ratio was more or less same in the adults (Fig. 3).

Since the biology of this species is not worked out under laboratory conditions due to its myrmecophilic life and coprophagous feeding habits, the significance of such patterns of changes in population cannot be adequately explained. The low population in other months, when the temperature and humidity did not register a drastic change, may be attributed to these insects going deeper into crevices as the gut contents of none of the co- habiting predaceous fauna are found to contain any remnants of *L. guerini*. The chance of migration is also ruled out by the negative results of the intensive search in the adjacent areas. Though these insects are alate, they are only short distance fliers. We also dug out some ant nests and recorded large number of these bugs in deeper parts of the ant nest.

*L. guerini* is a first record of a myrmecophiline and coprophagous reduviid (Ambrose & Livingstone 1979). *A. longipes* is the formicine ant that co-inhabit the crevices. They are found to congregate around the adults and nymphs of *L. guerini* and are also found to escort them to and fro during the feeding march. Though congregation of *A. longipes* in the microhabitat of *L. guerini* is the indication of the population of the latter, it is not a rule because in several localities where *A. longipes* congregate there is no sign of *L. guerini*. Therefore, the population of *A. longipes* and that of *L. guerini* are not complementary. But it is worthwhile to mention here that the tropical rain forests of the Western Ghats have a distribution of *L. guerini* also in very restricted pockets. Conditions in these habitats are also similar to those recorded in Walayar. The presence of the congregation of some species of ants in and around *L. guerini* in these habitats is also significant.

**Light trap:** Analysis of the data gathered from the light trap collections of 16 species of assassin bugs from a particular locality in an agroecosystem adjacent to the scrub jungles and semi-arid zones, has shown apparently no correlation between any perceptible fluctuations in the meteorological factors and population level (Fig. 4).

The maximum collection was made in July 1978, when the climatic conditions were found to be moderate. In December 1978, when the maxmum rainfall, was recorded only one assassin bug (*Ectomocoris cordatus* Wolff) was found attracted to light. And in general, August and September appear to be the lean period for the night activity of the alate reduviids.

Among the four subfamilies represented in the collection, Piratinae species are found to be the most abundant (9 species) followed by Stenopedinae (5 species). Acanthaspidinae and Harpactorinae are represented by only one species each. Fig.4 indicates that species of Piratinae have been collected throughout the year with a maximum record of twelve assassin bugs in a collection. Out of all the nine species of Piratinae five belong to the genus *Ectomocoris*. The Piratinae sp. and *Sirtheneaflavipes* Stal were collected only once, in March 1978 and July 1978 respectively. Among Piratinae *Ectomocoris cordatus* Wolff is the most abundant form followed by *E. quadriguttatus* Fabricius. All the five species of Stenopodinae, namely *Oncocephus fuscinotum* Reuter, *O. klug* Distant, *O. modestus* Reuter, *O. notatus* Klug and *Sastrapada baerensprungi* Stal have been recorded between March-July 1978 and January-June 1979 and totally absent between August-December 1978.

All the other subfamilies were found to be more specific in their occurrence. Acanthaspidinae, represented by only one species, namely *Pasira perpusilla* Walk. was collected only once (February 1978). Harpactorine species, namely, *Polididus armatissimus* Stal was collected in May and June 1978 and March and June 1979. It is significant to note the sporadic occurrence of this Harpactorine species in June 1978 collection.

None of these species collected has shown any correlation between their occurrence and meteorological factors, though temperature aparently has some influence in their periodicity.

## Discussion

The foregoing information suggests that in all the conditions of collection, the influence of

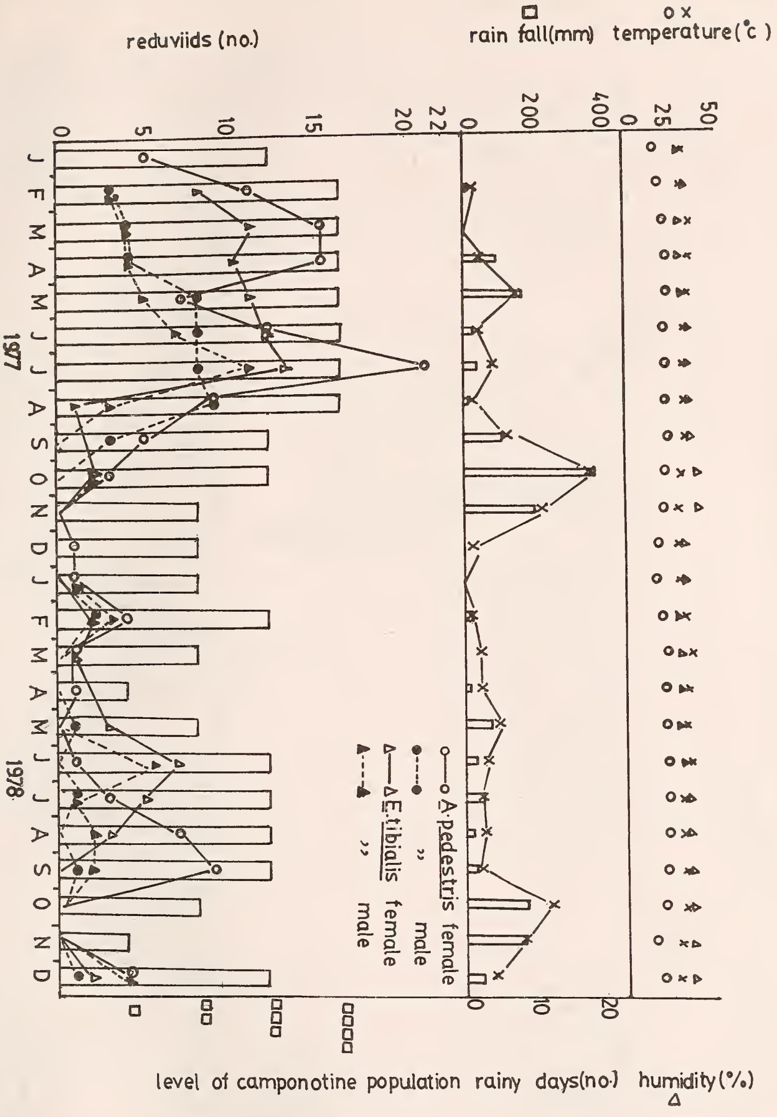

Fig. 1. Population dynamics of *A. pedestris* and *E. tibialis* in Chandrapuram semiarid zone.

meteorological factors on the population density of these bugs appears to be negligible. The fluctuations have direct correlations to the prey population fluctuations in the semi-arid zones and scrub jungles. It is also significant that the natural reduviid population in the semi-arid zone is female biased. This may be correlated to the development of cannibalistic tendency, the females preying upon the males soon after copulation and also to the shorter life span of the males

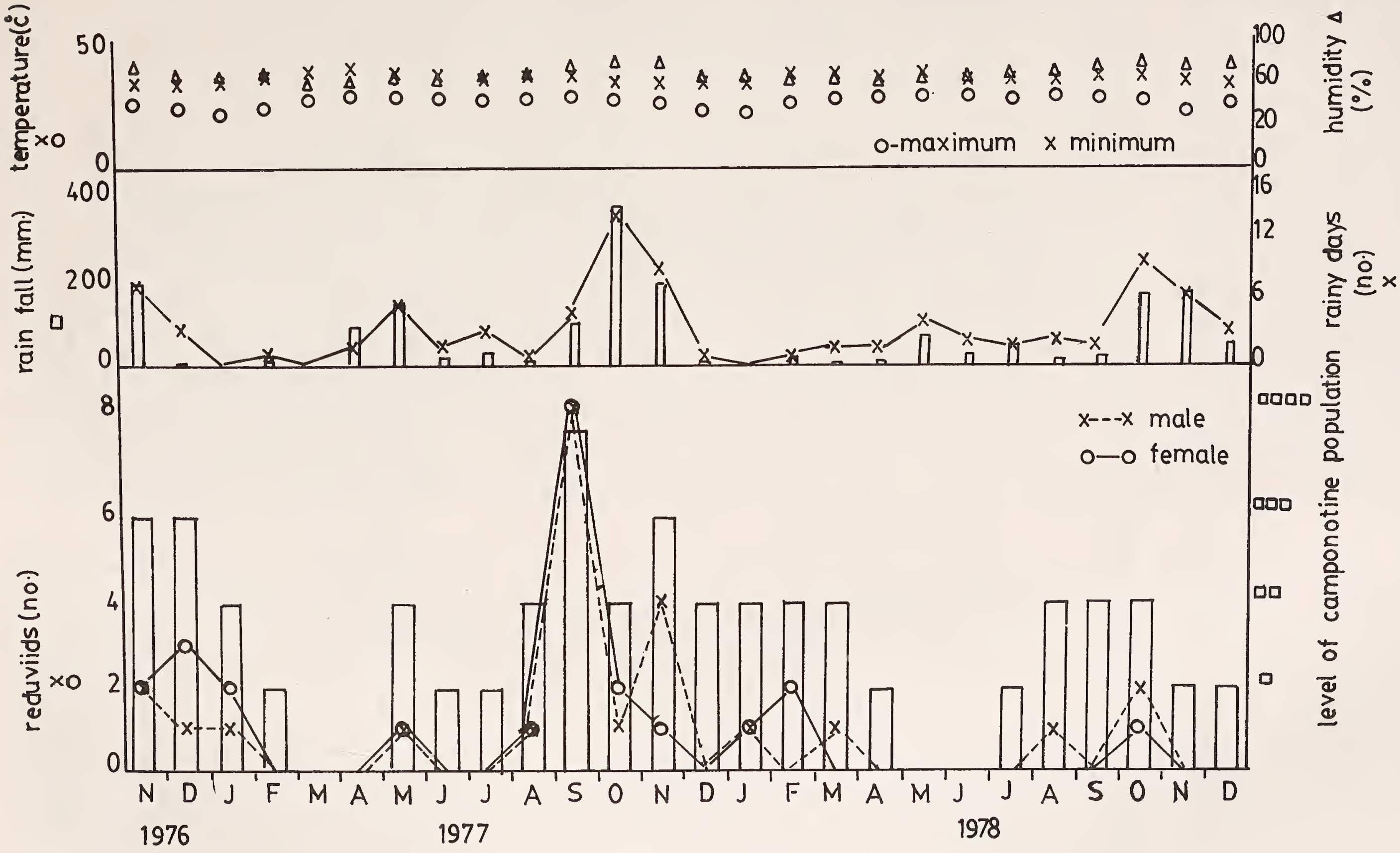

Fig. 2. Population dynamics of *A. pedestris* in Maruthamalai scrub jungle.

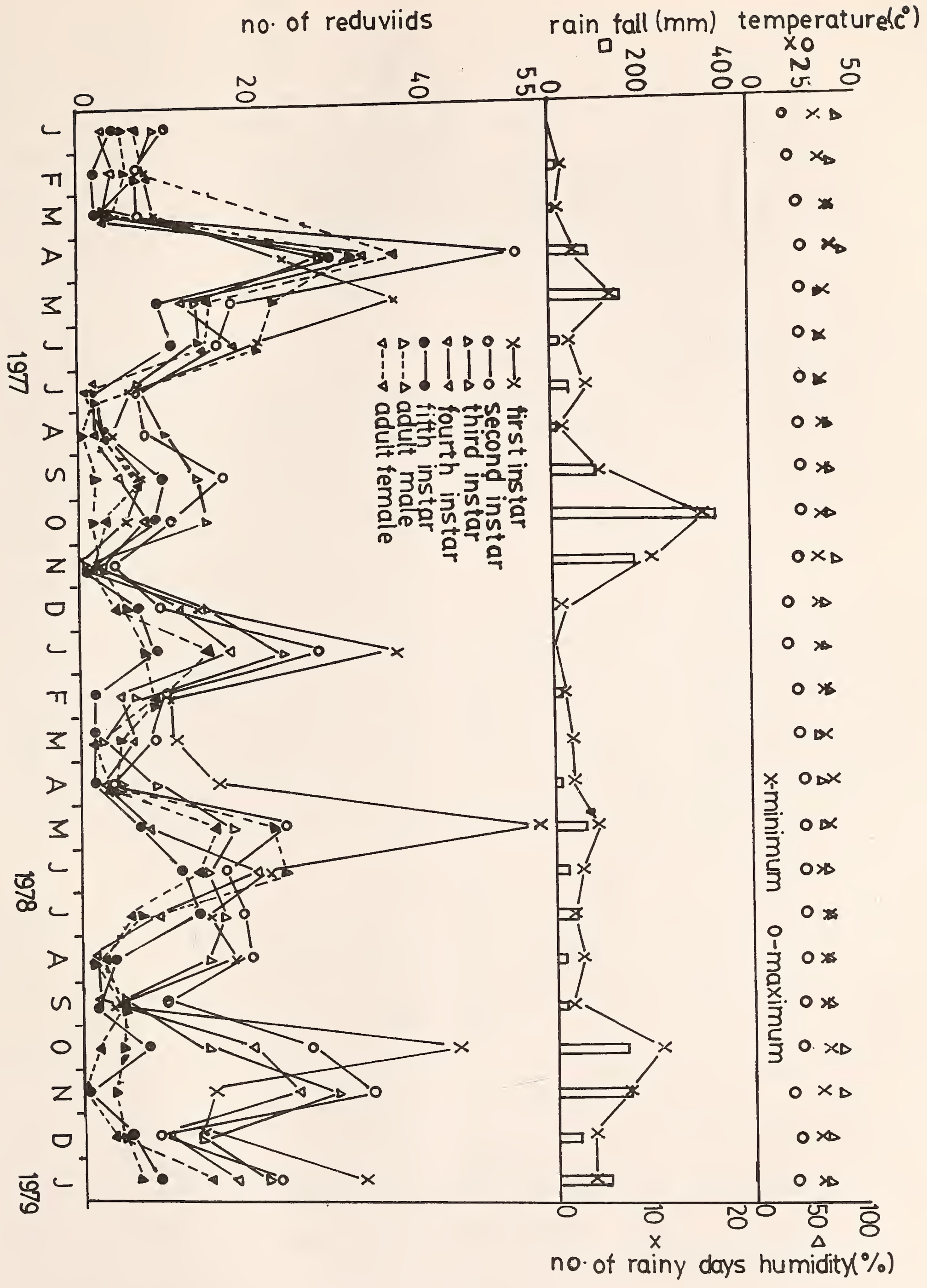

Fig. 3. Population dynamics of *L. guerini* in Walayar tropical rain forest.

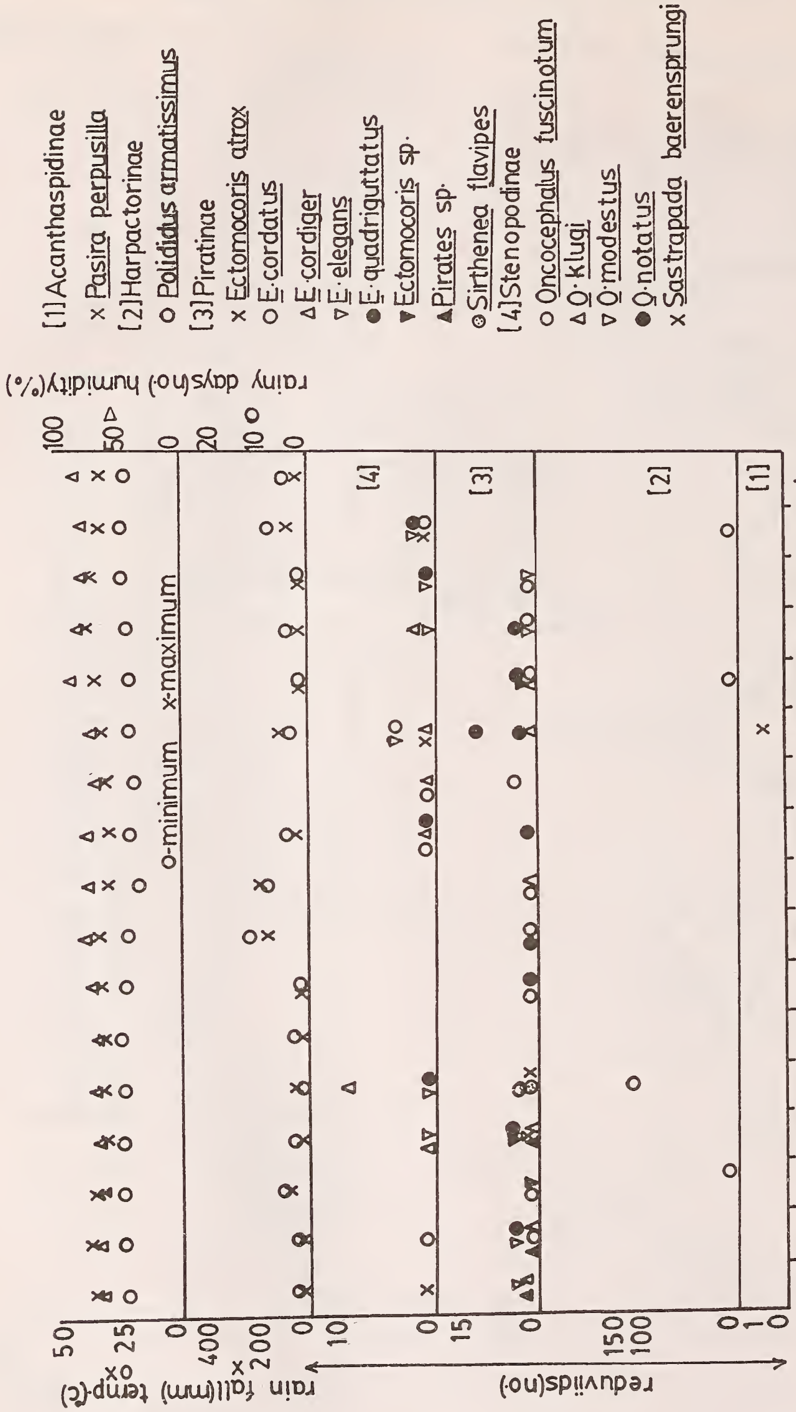

Fig. 4. Population dynamics of light attracted reduviids collected from an agroecosystem.

(Ambrose & Livingstone, 1978 a).

In the scrub jungles, when the camponotine population was relatively very high the sex ratio was found to be equal and *Acanthaspis pedestris* has been found to be cannibalistic, often the females predating upon the males, only when they are subjected to starvation. It is also evident that the predatory species migrate from place to place in search of their prey, when the population of latter is depleted in one particular period (Ambrose & Livingstone 1978 b). This may be the reason why the predators are totally absent when the prey is absent.

Nicholson (1958) and Clark *et al.* (1978) have considered the density of the prey population as the primary factor in controlling the population level of predators. Andrewartha and Birch (1969) have noted that the dispersal of the predators is correlated to the migration in search of prey. Milne (1957 a, b) has proposed the theory that the prey population is a density dependent factor for a predator and the present study corroborates Milne's theory. Reduviid population in the scrub jungle and semi-arid zones is dependent on camponotine ant population. Chitty (1960) maintains that the population level in a habitat is kept constant by the genetic factors of the species concerned. Pimentel (1961) considers this as a genetic feedback in the maintenance of population level of a particular species. Population studies of reduviids of different microhabitats indicate that *L. guerini* is bivoltine whereas others are either univoltine (*E. tibialis*) or multivoltine (*A. pedestris*). Since their population dynamics is not apparently regulated by climatic conditions, the authors are tempted to favour the genetic factor in population dynamics as a supplementary factor operating as a regulatory mechanism proposed by Chitty (1960) and Pimental (1961).

Goel (1978) from his lunar periodicity population count mechanisms, reported a high catch of hemipterans when there was high humidity and low rainfall. He further reported maximum collection of reduviids in the month of July. In the present investigations also, it was found that the maximum catch of reduviids has been in July.

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# FEEDING BEHAVIOUR OF THE MALABAR WOODSHRIKE *TEPHRODORNIS VIRGATUS SYLVICOLA* JERDON AT THEKKADY, KERALA[1]

LALITHA VIJAYAN[2]

Feeding behaviour of the Malabar Woodshrike *Tephrodornis virgatus* was studied at Thekkady, South India, from March 1980 to February 1981. It is a regular member of mixed-species feeding flocks (MFF). Monthly and seasonal variation in its participation in MFF is dependent mainly on its breeding season and that of most of its close associates. 25 species of birds show significant association with the Malabar Woodshrike in MFF and the probable reasons are explained. The benefit this species achieves might mainly be protection from predators; increased food acquisition by less vigilance, and increasing feeding time and efficiency is also speculated. This species, being a gleaner, flushes out insects for the attending species and also forms the leading and cohesive member of the mixed flocks.

## INTRODUCTION

A description of the Malabar Woodshrike with notes on its general biology has been given by Ali (1969) and Ali and Ripley (1983). The present study, though not a treatise on its ecology, deals with some major aspects of its feeding biology. The data were collected during 1980-81 while conducting a study on drongos.

The study area was a patch of moist-deciduous/semi-evergreen forest of about 150 ha. at Thekkady in the Periyar Tiger Reserve (9° 15' to 9° 40' N, 76° 05' to 77° 25' E) in Kerala, south India, at an elevation of 1050 m above mean sea level. The forest patch was a raised portion with low-lying grasslands on either side. The average temperature varied from a minimum of 16° C to a maximum of 35° C. The area receives both the southwest and northeast monsoons; the average annual rainfall during 1980 was 1440.9 mm and for the five years (1977 to 1981), 1707.2 mm.

## METHODS

Feeding of the Malabar Woodshrike was oberved along with the mixed-species feeding flocks (MFF), which were followed continuousy and the composition recorded every 15 minutes, noting the number of individuals of each species; each one of this forming one observation. The occurrence of each species in MFF was computed for each month and the relation of this species with others was analysed in detail.

## RESULTS AND DISCUSSION

The Malabar Woodshrike is mainly insectivorous, searching for insects and caterpillars on the stems or leaves (gleaning) for most part of the time or catching insects like a flycatcher (flycatching or flycatcher-gleaning) as described for the insectivorous passerines by Croxall (1977). It is noted as taking part in the mixed hunting parties of the forests Ali (1969) and Ali and Ripley (1983) and as one of the regular members in the mixed-species feeding flocks at Thekkady (Vijayan 1984).

Altogether, 2199 observations were made on the MFF from March 1980 to February 1981. The Malabar Woodshrike was noticed in 35% of the observations. As its occurrence was above 25% it is considered as a regular member, as done by Croxall (1976). The number of individuals of this species in MFF varied from two to 11 with an average of four.

**Seasonal variation in frequency of occurrence in MFF:** The frequency of occurrence of the Malabar Woodshrike in MFF varied in different seasons and months (Table 1), the minimum being in summer and the maximum in spring as noticed

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in other regular and occasional regular members (Vijayan 1984, Vijayan and Joshi (in prep.). Change in the participation of species in MFF results in a change in the flock composition in different seasons, as noticed in Brazil (Davis 1946), Japan (Ogasawara 1965) and Australia (Bell 1980). At Thekkady most of the birds breed in summer and have less flocking tendency as reported elsewhere (Sedgwick 1949, Moynihan 1962, McLure 1967, Morse 1970 and Fairchild *et al.* 1977).

The Malabar Woodshrike, though breeding from January to May, has less occurrence in MFF only during March and May. It might be because of the low participation of the major active species such as the Bronzed Drongo and the Scarlet Minivet with which it has a significant association as shown in Table 2, and also by the strong positive correlation of its monthly occurrence with that of the above species ($r = 0.82$, $p<0.01$ and $r = 0.92$, $p<0.001$ respectively). Its low frequency of occurrence in MFF in October is also in accordance with that of the Scarlet Minivet, which has a second breeding season during this period.

The high occurrence of this species in MFF during December-January-February is in relation to the activity of many species. The complexity of the flock with many species and more types of mixed flocks were noticed before the beginning of the breeding season in relation to the greater breeding activity and energy requirement of most of the species.

**Association with other birds in MFF:** The percentage of occurence of the Malabar Woodshrike with every other species in the flocks was calculated and in order to test the significance of association, the chi-square value was calculated. Association with some species was not significantly different from random as with that of some regular members like Racket-tailed Drongo, Yellowbrowed Bulbul and Goldfronted Chloropsis. While it showed close association with many species (Table 2), it had negative association with Jungle Babbler and Hill Myna (the observed value was less than the expected value, thereby showing an avoidance or no preference for its company).

The probable factors affecting the association of the Malabar Woodshrike with other species in mixed flocks are the foraging zones, foraging habits and the size of the species as explained for drongos (Vijayan 1984). As the Malabar Woodshrike usually foraged in the middle and upper strata of the canopy, its association was also with species foraging in these zones. The Jungle Babbler, which mainly utilized the ground and lower strata of the canopy, was negatively associated with this species. Similar association of species with common foraging zone is reported earlier by Bell (1980) in Australia and Waser (1984) in East Africa. The preferred size of prey is also supposed to be a common factor in this relationship of almost similar sized birds in mixed feeding flocks as found by Mac Donald and Henderson (1977) in Kashmir.

**Significance in MFF:** The major benefit to the Malabar Woodshrike in associating with MFF appeared to be protection from predators. More aggressive species like drongos, especially the Racket- tailed Drongo, chased away predators (Vijayan 1984). Shikra, Crested Serpent Eagle

TABLE 1

PERCENTAGE OCCURRENCE OF MALABAR WOODSHRIKE IN MIXED- SPECIES FEEDING FLOCKS AT THEKKADY DURING 1980-81

| Month & year | Mar. 1980 | April | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Jan. 1981 | Feb. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| %Occurrence | 5 | 29 | 4 | 47 | 29 | 35 | 29 | 13 | 30 | 48 | 53 | 45 | 35 |
| No. of obs. of flocks | 42 | 59 | 45 | 110 | 306 | 226 | 260 | 257 | 142 | 245 | 243 | 264 | 2199 |

TABLE 2
ASSOCIATION OF MALABAR WOODSHRIKE
WITH OTHER SPECIES
IN MIXED SPECIES FEEDING FLOCKS
AT THEKKADY DRUING 1980-'81

| | Species | $X^2$ Value |
|---|---|---|
| 1. | Scarlet Minivet | 179.70 |
| 2. | Velvetfronted Nuthatch | 83.32 |
| 3. | Bronzed Drongo | 195.50 |
| 4. | Grey Tit | 86.01 |
| 5. | Goldenbacked Woodpecker | 45.10 |
| 6. | Southern Tree Pie | 20.16 |
| 7. | Jungle Babbler | -73.74 |
| 8. | Tree Pie | 15.60 |
| 9. | Grey Drongo | 31.30 |
| 10. | Small Minivet | 38.22 |
| 11. | Small Green Barbet | 9.621 |
| 12. | Flowerpeckers | 6.721 |
| 13. | Pigmy Woodpecker | 13.51 |
| 14. | Paradise Flycatcher | 54.08 |
| 15. | Leaf warblers | 26.05 |
| 16. | Threetoed Goldenbacked Woodpecker | 59.50 |
| 17. | Heartspotted Woodpecker | 55.93 |
| 18. | Yellownaped Woodpecker | 6.941 |
| 19. | Golden Oriole | 5.182 |
| 20. | Blackheaded Oriole | 56.91 |
| 21. | Whiteheaded Blyth's Myna | 8.471 |
| 22. | Large Indian Cuckooshrike | 18.39 |
| 23. | Blackheaded Cuckooshrike | 13.52 |
| 24. | Drongo Cuckoo | 18.10 |
| 25. | Grackle or Hill Myna | -10-17[1] |

Note: 1 shows level of significance of $X^2$ $P < 0.01$
2 has P and all others have $P < 0.001$

and Brown Fish Owl marauded among the flocks, the first one more frequently than others. In every instance, though almost all the birds produced alarm calls, the drongos and sometimes the Tree Pies also went forward to chase the predators. No successful attack on the flocks was observed. But a few species like Shikra, Brahminy Kite, Grey Hornbill and Tree Pie were observed capturing solitarily feeding Small Green Barbet, Magpie Robin and Malabar Lorikeet.

The alarm calls produced by various species were continuous, with various imitation calls which are considered to be a convergence mechanism in mixed flocks for disguise, as observed by Bernard (1979). This, along with the tight bunching of individuals, makes it difficult for the predator to single out an individual (Tinbergen 1951). Dekker (1980) has found that solitary prey individuals were killed by Peregrine Falcon more often than individuals in flocks. Thus flocking is advantageous to all the members of the flock as reported earlier by Moynihan (1962), Morse (1970, 1973), Buskirk *et al.* (1972), Buskirk (1976), Gaddis (1980) and Greig-Smith (1981).

Besides providing protection and increased corporate vigilance by the members, flocking might also increase the feeding time as observed by Metcalfe (1984) and Monaghan and Metcalfe (1985).

Whether the foraging efficiency of the Malabar Woodshrike is increased owing to its association with MFF is not clear; although Ogasawara (1970), Kreba (1973), Fairchild *et al* (1977) and Geigsmith (1978 a & b) maintain that though the gleaners do not appear to benefit directly, their feeding efficiency might be improved. As the mixed flocks covered more areas feeding actively, the members might be benefiting from not searching in areas already depleted by others.

The Malabar Woodshrike being mainly a gleaner is followed by the attending species such as drongos, which could procure food by spending less energy by catching insects flushed out by the gleaners.

The Malabar Woodshrike lead the MFF to new areas, and were followed by other species; this has been noticed in other areas of the Western Ghats (V.S. Vijayan, pers. comm.). Its active movements and loud and frequent calls might be attracting species to the flocks, thus acting as a cohesive force of the MFF.

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# MATERIAL FOR THE FLORA OF MAHABALESHWAR - 8
## PTERIDOPHYTES

P.V. BOLE AND M.R. ALMEIDA

(Continued from Vol. 83(3): 594)

### KEY TO THE FAMILIES OF PTERIDOPHYTA OF MAHABALESHWAR

1. Leaves simple, one nerved, close and small relatively to the axis. Sporangia orbicular or semi-orbicular, compressed, 1-celled, 2-valved, at the base of the sporophylis which are grouped in a spike ........ 2
- 2\. Isosporous, leaves multifarious without ligule ........ LYCOPODIACEAE
- 2\. Heterosporous ........ 3
  - 3\. Leaves often 4-farious and differing in shape and size, with a microscopic ligule ........ SELAGINELLACEAE
  - 3\. Leaves multifarious with ligule ........ ISOETACEAE

1. Leaves large relatively to the axis, multinerved and usually compound. Sporangia on the margins or on the back of the leaves or on modified leaves or borne in sporocarps ........ 4
- 4\. Sporangia produced from plural sub-epidermal cells. Sori without an annular ring ........ OPHIOGLOSSACEAE
- 4\. Sporangia developed from a single epidermal cell. Sori with an annular ring ........ 5
  - 5\. Sori opening across the apex, furnished with a short horizontal ring ........ OSMUNDACEAE
  - 5\. Sori not opening across the apex ........ 6
    - 6\. Sori two-valved, opening down the side, crowned by a operculiform complete ring ........ SCHIZAEACEAE
    - 6\. Sori opening by bursting as a stroma, surrounded by a jointed vertical and uncomplete elastic ring ........ 7
      - 7\. Indusium usually present, true or false ........ 8
        - 8\. Spores trilete ........ 9
          - 9\. True indusium present ........ DENSTADTIACEAE
          - 9\. True indusium not present ........ 10
            - 10\. Sori restricted more or less in the centre of the frond ........ GYMNOGRAMMACEAE
            - 10\. Sori running along the margins or covering entire lower surface ........ 11

11. Margins irregularly folded and very much curled ........ SINOPTERIDACEAE

11. Margins entire or deeply cut, reflexed but not curled ........ 12
- 12\. Sori continuous, exposed at maturity ........ PTERIDACEAE
- 12\. Sori broken at intervals, covered by reflexed margins even at maturity ........ ADIANTACEAE

8. Spores monolete ........ 13

13. Sori pocket-shaped or flap-like, veins free ........ DAVALLIACEAE

13. Sori circular, veins reticulate ........ 14
- 14\. Indusium linear or oblong or sometimes horse–shoe shaped, opening towards the mid-rib, outer margins attached to theveins ........ 15
  - 15\. Scales clathrate; the two vascular bundles at the base of the stipe uniting upwards in X-Shape ........ ASPLENIACEAE
  - 15\. Scales not clathrate; vascular bundles unite in U-shape ........ ATHYRIACEAE
- 14\. Indusium elliptical, sub-globose or reniform, fixed to the lamina in the centre or at the sinus ........ 16
  - 16\. Pinnules with reticulate veins ........ ASPIDIACEAE
  - 16\. Pinnules with parallel veins ........ THELYPTERIDACEAE

7. Indusium absent ........ POLYPODIACEAE

### LYCOPODIACEAE

*Lycopodium* Linn.

1. **Lycopodium hamiltonii** Spreng. Syst. 5: 429, 1828; Mahabale, J. Univ. Bombay 6(5): 69,1938.

*L. obtusifolium* Hamilt. *in* Don, Prod. Fl. Nepal. 18, 1828 (non Sw.).

*L. alvifolium* Wall. *ex* Hook. *et* Grev. Ic. t. 233, 1829 .

*L. empetrifolium* Dalzell, Hook., J. Bot. 4: 113, 1853.

*L. obtusatum* Fairbank, Sensu Birdwood, *in* J. Bombay nat. Hist. Soc. 10(3): 430, 1896.

This epiphytic *Lycopodium* is found near Wada, on the way to Mahabaleshwar, especially on tall mango trees. It grows erect or sub-erect on the host plant in the monsoon, but is usually seen dried and hanging soon after the rains stop. It is a rare species and near Wada it is found at one or two spots only.

Spores: September – December.

Specimen collected: M.R. Almeida – 247.

### SELAGINELLACEAE

*Selaginella* Pallisot de Beauvois (nom. cons.)

1. Median leaves not aristate; plant 20 cm tall ................................................ *S. delicatula*
1. Median leaves aristate; plants less than 10 cm ................................................ *S. proniflora*

1. **Selaginella delicatula** (Desv.) Alston, J. Bot. 70: 282, 1932.
*Lycopodium delicatulum* Desv., Poir. Encycl. Suppl. 3: 584, 1814.
*S. canaliculata* Graham, Cat. Bombay Pl. 243, 1839.

This is a common species in shady places. It grows on hill- slopes in abundance. It is an erect species, occasionally producing a few adventitious stilt roots, from the lower parts of the stem.

SPECIMEN SEEN: M.B. Vasantha - S.N. (Sept. 1967).

2. **Selaginella proniflora** (Lamk.) Baker, J. Bot. 22: 150, 1855. *Lycopodium proniflora* Lamk. Encycl. 3: 652, 1791.
*L. caespitosum* Dalz., Hook. Kew Journ. Bot. 4: 114, 1852 (non Blume 1828).

This species is found on rocks and on bouldered soil in clusters. The plant is seen to be slightly spreading in juvenile stage but assumes an erect position later.

OCCURRENCE: August–November.
SPECIMEN: P.V. Bole–2306.

### ISOETACEAE

*Isoetes* Linn.

1. Peripheral strands present; velum rudimentary ........................................................ *I. dixitei*
1. Peripheral strands absent; velum almost complete ................................................ *I. sahyadrica*

1. **Isoetes dixitei** Shende, J. Univ. Bombay 14: 50, 1945.

Found in shallow pools of water on Wilson Point, during the second half of monsoon.

OCCURRENCE: July.
SPECIMEN: M.R. Almeida— s.n. (BLAT).

2. **Isoetes sahyadrica** Mahabale, Curr. Sci. 7: 61-2, 1938.

This species is also described from similar habitat as that of *I. dixitei* Shende. Unfortunately, type materials are not preserved and presence of peripheral strands on which *I. dixitei* is segregated from it could not be verified in the absence of type materials. Otherwise both have common characters. All specimens we have examined have shown peripheral strands.

### OPHIOGLOSSACEAE

*Ophioglossum* Linn.

1. **Ophioglossum reticulatum** Linn. Sp. Pl. 2: 1063, 1753; Gray in Gazett. Bombay Pres. 25:377, 1886; Blatter, J. Bombay nat. Hist. Soc. 18(3): 612, 1908; Mahabale, J. Univ. Bombay 6(5): 109, 1938.

Found under the shade of trees on hill—slopes and among grasses in the plains in monsoon. It can be easily recognised from other species due to its long fleshy and running roots.

OCCURRENCE: July–November.
SPECIMEN SEEN: M.R. Almeida–755.

### OSMUNDACEAE

*Osmunda* Linn.

1. **Osmunda regalis** Linn. Sp. Pl. 2: 1065, 1753; Gray, Gazett. Bombay Press. 25: 377, 1886; Birdwood, J. Bombay nat. Hist. Soc. 2(2): 126, 1887; Blatter & d'Almeida, Ferns of Bombay, 192, 1922; Eubank J. Bombay nat. Hist. Soc. 36(1): 193, 1932.

The royal fern occurs mostly on the banks of rivers and streams. usually its roots are submerged in running water.

OCCURRENCE: Throughout the year.
SPECIMEN SEEN: M.R. Almeida–s.n.

### SCHIZAEACEAE

*Lygodium* Sw.

1. **Lygodium flexuosum** (L.) Sw. in Schrad. Journ. 1800/2; 106, 1801; Graham, Cat. Bombay 242; Birdwood, in J. Bombay

nat. Hist. Soc. 1(4): 211, 1886; Gray, 377; Blatter & d'Almeida, 195.

*Ophioglossum flexuosum* Linn. Sp. Pl. 2: 1063, 1753.

A seasonal monsoon fern which starts growing at the beginning of the monsoon and lasts until January.

### PTERIDACEAE

*Pteris* Linn.

1. Fronds simply pinnate ........ 2
  2. Pinnae more than 3 cm wide........ *P. pellucida*
  2. Pinnae less than 1.5 cm wide........ *P. vittata*
1. Fronds bipinnate ........ 3
  3. Lowest pinnae having more than one lobe (up to 5 lobes) on the abaxial side. *P. quadriaurita* (p.p.)
  3. Lowest pinnae having only one lobe on abaxial side ........ 4
    4. Copious stiff hairs on rachis and costae. ........ *P. asperula*
    4. No stiff hairs on rachis and costae........ 5
      5. Veinlets usually once forked and then free ........ *P. quadriaurita* (p.p.)
      5. Lowest pairs of veinlets of the adjoining veins unite in pairs into an arch........ *P. biaurita*

1. **Pteris asperula** J. Sm. in Hook. J. Bot. 3: 405, 1841.

*P. quadriaurita* var. *setigera* Hook. Sp. Fil. 2: 181, 1858.

A common species in shady places. It can be easily separated from its allies due to the presence of prickly hairs on its costae.

SPECIMEN SEEN: M.R. Almeida–155.

2. **Pteris biaurita** Linn. Sp. Pl. 1076, 1753; Eubank, J. Bombay nat. Hist. soc. 36: 191, 1932.

*Campteria biaurita* (Linn.) Hook. Gen. Fil. t. 75A, 1841.

*P. quadriaurita* forma *biaurita* (Linn.) Blatter & d' Almeida, Ferns of Bombay, 89, 1922.

Very common all over Mahabaleshwar and occurs in association with *Pteris quadriaurita* Retz. from which it is very difficult to separate, in sterile condition. In herbarium, however, it could be easily separated due to its costular elongated areoles.

SPECIMENS EXAMINED: S.V. Ranade–s.n.

3. **Pteris pellucida** Presl., Rel. Haenk. 1:55, 1825; Gray, 376 Birdwood, 211; Blatter & d'Almeida, 86.

Found in very thickly shaded places and grows generally on black, humid and loose soil.

SPECIMEN EXAMINED: P.V. Bole–127.

4. **Pteris quadriaurita** Retz., Obs. 6: 38, 1791; Gray, 376; Birdwood, 211; Eubank, 190; Blatter & d'Almeida, 88.

One of the common species all over Mahabaleshwar. It is usually found on the sloping grounds on yellowish loamy soil.

SPECIMEN SEEN: G.L. Shah–10659.

5. **Pteris vittata** Linn. Sp. Pl. 2: 1074, 1753; *P. longifolia* auct. (non Linn. 1753); Hook., Sp. Fil. 2: 157, 1858; Bedd. F.S.I. 11, t. 33, 1863 & Handb. 106, f. 55, 1883; Gray, 376; Birdwood, 431; Blatter & d'Almeida, 83.

A common species found in crevices of stone walls. It is also found on the ground but it does not produce luxuriant growth on soil. It grows more gregariously in winter than in monsoon.

SPECIMEN SEEN: E. Gonzalves–s.n.

### SINOPTERIDACEAE

*Aleuritopteris* Fee

1. Only stipes paleaceous ........ *A. farinosa*
1. Stipes as well as rachia paleaceous ........ *A. albomarginata*

1. **Aleuritopteris albomarginata** (Clarke) Ching, in Hong Kong Nat. 10: 1999, 1941.

*Cheilanthes albomarginata* C.B. Clarke, in Trans. Linn. Soc. London 2 (Bot.): 456, t. 52, 1880; Bedd. Handb. 94, 1883; Blatter & d'Almeida, 79, f. 6.

A quite common fern occurring mostly on embankments.

SPECIMEN SEEN: B. Balamani–304.

2. **Aleuritopteris farinosa** (Forsk.) Fee, Gen. Fil. 153, 1852.

*Pteris farinosa* Forsk. Fl. Aegypt. Arab. 187, 1775; Graham, Cat. Bombay Pres. 241, 1839.

*Cheilanthes farinos* (Forsk.) Kaulf. Enum. Fil. 202, 1824; Bedd. F.S.I. 65, t. 191, 1863 & handb. 92; Birdwood, 211; Gray. 376; Blatter & d'Almeida 77, t. 6, f. 31; Eubank, 194.

A common and abundant species on open embankments. It is generally known as silver fern due to powdery mildew present on the under surface of leaves. it is a typical monsoon species and starts withering and curling its leaves immediately after the rains stop.

SPECIMEN SEEN: P.V. Bole–1219.

### GYMNOGRAMMACEAE

*Annogramma*

1. **Annogramma leptophylla** (Linn.) Link., Fil. Sp. Cultae, 137, 1841.

*Polypodium leptophyllum* Linn., Sp. Pl. 2: 1092, 1753. *Gymnogramme leptophylla* (Linn.) Desv., Berl. Mag. 5: 305, 1811; Bedd., F.S.I. 88, t. 270 & Handb. 382; Gray, 376; Blatter & d'Almeida, 175.

Found on the sides of old walls, and on tree-trunks during monsoon and in winter.

SPECIMEN COLLECTED: M.R. Almeida – 712.

### ADIANTACEAE

*Adiantum* Linn.

1. Fronds simply pinnate .......................................................... 2
    2. Pinnae petiolate, kidney-shaped, not deeply incised ............................................... *A. philippensis*
    2. Pinnae sessile, fan-shaped, deeply incised ................................................... *A. incisum*
1. Fronds tripinnate or decompound ..................... *A. cuneatum.*

1. **Adiantum incisum** Forsk. Fl. Egypt. Arab. 187, 1775;

*A. caudatum* auct. (non Linn. 1753), quod, Bedd. Ferns Brit. India, t. 2, 1868 & Handb. 82, 2.44; Gray, 376; Blatter & d'Almeida, 61.

A rare species in shady places. It grows on black soil, which is rich in humus due to the decayed leaves.

SPECIMEN SEEN: M.S. Samant–s.n.

2. **Adiantum cuneatum** Langs. *et.* Fish., Ic. Fil. 23, t. 26. 1810; Blatter & d'Almeida, 72, f. 28.

This,an introduced garden species sometimes found growing wild, probably as an escape from cultivation.

SPECIMEN COLLECTED: M.R. Almeida – 742.

3. **Adiantum philippense** Linn. Sp. Pl. 2: 1094, 1753.

*A. lunulatum Burm. f., Fl. Ind. 235, 1768; Graham, 242; Beddome, Handb.,115; Birdwood, 211; Gray, 376; Blatter & d'Almeida, 92, f. 35.*

A common and abundant monsoon species found all over in shady places. It grows luxuriantly on embankments but it disappears immediately after monsoon. Some times it is seen growing on trees in crevices of branches but it is not an epiphyte.

SPECIMEN COLLECTED: M.R. Almeida – 246.

### DENSTADTIACEAE

*Pteridium* Scop

1. **Pteridium aquilinum** (Linn.) Kuhn, in V. Deck. Reis. 3/3, Bot. 11, 1879.

*Pteris aquilina* Linn., Sp. Pl. 2: 1075, 1753; Graham, 241; Bedd., F.S.I. 14, t. 42 & Handb. 115; Birdwood, 211; Gray, 376; Blatter & d'Almeida, 92, f. 35.

The commonest and dominant species of plains of higher hills at Mahabaleshwar. It is the first species to reappear after any forest clearing is done. It is locally used for thatching the roofs of huts.

SPECIMEN COLLECTED: M.R. Almeida – 155.

### DAVALLIACEAE

*Leucostegia.* Presl.

1. **Leucostegia immersa** Presl, Tent. Pterid. 95, 1836; beddome, Handb. 51; Birdwood, J. Bombay nat. Hist. Soc. 10(3): 431; Blatter & d'almeida, 42, f. 5A; Eubank, 191.

*Acrophorus immersa* Moore, in Proc. Linn. Soc. London 2: 286, 1839; Bedd., F.S.I. 4, t. 11, 1863; Gray, 376.

Quite a common epiphytic or lithophytic species at Mahabaleshwar. It is a common fern but it lasts up to January end only.

SPECIMEN SEEN: M.R. Almeida – 735.

### THELYPTERIDACEAE

*Christella* Holttum

1. **Christella papilio** (Hope) Holttum Apud Nayar, Comp. Ferns Brit. India 208, 1974.

*Nephrodium papilio* Hope, J. Bombay nat. Hist. Soc. 12: 625, 1899.

*Nephrodium molle* var. *major* Bedd., Handb. Suppl. 76, 1892 (p.p.).

Quite a common fern on sides of water-courses and in moist shady forest undergrowths.

### ASPLENIACEAE

*Asplenium* Linn.

1. Epiphytes; texture thick, leathery ................. *A. indicum*
1. Terrestrial; texture thin, membranaceous ......................................... *A. inaquilaterale*

1. **Asplenium inaquilaterale** Willd., Sp. Pl. (ed.4) 5: 322, 1810; Hieron, Hedwigia 61: 22, 1919.

*A. trapeziforme* (non Roxb., 1832) sensu Beddome, F.S.I. 45, t. 134, 1863; Gray, 376.

*A. lunulatum* var. *trapeziforme* Beddome, Handb. FBI 148, 1883; Birdwood, J. Bombay nat. Hist. Soc. 2((2); 127, 1887; Blatt. & McCann. 105 (p.p. excluding synonym)

Found in white loamy soil and calciferous deposits. It is a rare fern at Mahabaleshwar.

SPECIMEN SEEN: N.Y. Dalzell – s.n. (1878).

2. **Asplenium indicum** Sledge, in Bull. Brit. Mus. (Nat. Hist.) Botany, 3(6): 264-5, 1965.

*Asplenium laciniatum* sensu Beddome, F.S.I. 49, t. 145, 1863 & Handb. 154, 1883 (non Don, 1825); Birdwood, 211; Blatter & d'Almeida, 108; Eubank, 193.

*A. planicaule* Wall. ex Metten., Asplen. 157, 1859; Gray, 376; Birdwood, J. Bombay nat. Hist. Soc. 1(4): 211 (non lows, 1858).

A common epiphytic fern growing mostly on *Eugenia* and *Memecylon* species. But after wet season it is found in dried condition and fronds are seen hanging on host stems.

### ATHYRIACEAE

1. Sori only one on the acroscopic sides of the veins; annuals ...................................................... *Athyrium*
1. Sori bothsides of the veins; perennials ........... *Diplazium*

*Athyrium* Roth

1. Frond simply pinnate, or sometimes lobed with much larger acroscopic lobe to each pinna; pinnae sessile ...... *A. falcatum*
1. Fronds bipinnate or tripinnate; no large lobe to the acroscopic side of the pinnae; at least lower pinnae petiolate ............................................................ 2
    2. Fronds up to 30 cm tall................................................ 3
        3. Sori usually kidney-shaped ................ *A. anisopterum*
        3. Sori ovate, running alongtheveins ...................................... A. hohenakerianum
    2. Fronds above 40 cm tall ................................................ 4
        4. Fronds tripinnate................................. *A. spinulosum*
        4. Fronds bipinnate ...................................................... 5
            5. Lobes ovate, margins and apex serrate ...................... *A. filix- foemina* var. *flabellata*
            5. Lobes delotoid, margins and apex fimbriate ...................... *A. filix-foemina* var. *pectinata*

1. **Athyrium anisopteris** Christ. in Bull. Herb. Boiss. 6: 962, 1898; Sledge, in Bull. Brit. Mus. Bot. 2(2): 289, 1962.

*A. macrocarpum* Bedd., F.S.I. 51, t. 152, 1863 & Handb. F.B.I. 165, 1883 (p.p.) (non *Aspidium macrocarpum* Blume); Blatter & d'Almeida, 112.

A rare species found near watercourses. It is very much allied to *A. hohenakerianum* Moore, but it differs from it in having kidney shaped sori.

OCCURRENCE: October.

SPECIMEN SEEN: M.R. Almeida – 711.

2. **Athyrium falcatum** Bedd., Ferns South India, 51, t. 151, 1863 & Handb. F.B.I. 164; Gray, 376; Blatter & d'Almeida, 113; Eubank, 194.

*A. drepanophyllum* Baker, in Hook. & Baker, Syn. Fil. (ed. 2) 226, 1868.

One of the common monsoon species found all over Mahabaleshwar. It is generally found on earthen embankments in semi-shaded places. It has a fleshy succulent stem.

OCCURRENCE: July - October.

SPECIMEN COLLECTED: M.R. Almeida – 706.

3. **Athyrium filix-foemina var. flabellata** Wall. ex clarke, in Trans. Linn. Soc. London, 2(bot. 1) 493, t. 60, 1880; Beddome, Handb. 170; Birdwood, 123; Blatter & d'Almeida 115.

One of the common ferns at Mahabaleshwar. It grows on shady earthen embankments. It is usually seen with *A. hohenakerianum* Moore and *A. falcatum* Bedd., and is very difficult to separate from the former in dried herbarium material but is easily recognisable in the field due to its less succulent nature.

SPECIMEN SEEN: M.R. Almeida – 725a, 727.

4. **Athyrium filix-foemina var. pectinata** Wall. ex Clarke, in Trans. Linn. Soc. London, 2(bot. 1); 492, t. 57, 1880; Blatter & d'Almeida, 114.

*A. pectinatum* Wall. ex Hope, in J. Bombay nat. Hist. Soc. 14(2): 253, 1902 (non Bedd., 1863).

*A. filix-foemina* (non Linn. 1753) sensu Bedd. F.S.I. 51, t. 154, 1863.

This variety is also found very commonly along with its allies. It generally grows on earthen embankments in monsoon but it dries off soon after the rains stop.

SPECIMEN SEEN: M.R. Almeida – 710.

5. **Athyrium hohenakerianum** (Kze.) Moore, Index Fil. 126, 1857; Beddome, F.S.I., 150 & Handb. 163; Blatter & d'Almeida, 111, f. 9; Eubank, 194.

*Allantodea hohenakerianum* Kuntze, in Schk. Fil. suppl. 2:63, t. 26, 1837.

The most succulent among the ferns. It is found on earthen embankments during monsoon, and is the first species to dry off immediately after rains.

SPECIMEN SEEN: P.V. Bole – 1116.

6. **Athyrium spinulosum** (Maxim) Milde, Bot. Zeit. 376, 1866; Bedd., Handb. 161.

*Cystopteris spinulosa* Maxim., Mem. Acad. St. Petersb. 9: 340, 1859.

There is one specimen of this species at central National Herbarium, Calcutta identified by its collector as *Athyrium filix-foemina*. On the specimen there are remarks written in pencil. "This is a remarkable cut and developed fern, which I can not name". On this sheet there is also a mark of initials followed by date – 25/1/6, which according to the staff of CNH, is the signature of Sir George Watt. They are of the opinion that this sheet is from King's collection.

### *Diplazium* Sw.

1. **Diplazium esculentum** (Retz.) Swartz., Syn. Fil. 92 & 285, 1806.

*Hemionitis esculenta* Retz., Obs. Bot. 38, 1791.

*Callipteris easculenta* J. Sm. ex Moore et Houst., Gard. Mag. bot. 3: 265, 1851; Bedd., F.S.I. 54, t. 164; Gray, 376.

*Anisopteris esculentum* (Retz.) Presl, Rel. Hoenk. 1(6): 45, 1836; Bedd., Handb. 192, f. 94; Blatter & d'Almeida, 120; Eubank, 193.

A common fern on riverbanks. Sometimes seen partially submerged in water It grows well inland and is also grown in pots at several places.

SPECIMEN SEEN: T. Cooke – s.n.

### ASPIDIACEAE

1. Veins anastomosing ........................................ *Tectaria*
1. Veins free ........................................................ 2
    2. Indusium hairy; whole plant covered with silky unicellular hairs ........................ *Hypodematium*
    2. Indusium glabrous; plants not covered with unicellular hairs ........................ *Dryopteris*

### *Dryopteris* Adanson

1. Fronds ovate-lanceolate, dimorphic; dimorphic; fertile pinnae almost half of the size of those of sterile ........................ *D. cochleata*
1. Fronds more or less triangular; fertile as well as sterile pinnae similar in size and shape ........................ *D. sparsa*

1. **Dryopteris cochleata** (D. Don) C. Chr., Index Fil. 258, 1905.

*Nephrodium cochleatum* D. Don, Prod. Fl. Nepal. 6, 1825.

*Lastrea cochleata* (D. Don) Moore, Ind. Fil. 88, 1857; Gray, 376.

*L. filix-mass* var. *cochleata* Bedd., F.S.I. 51, t. 115, 1863 & Hanb. 250; Birdwood, 128; Blatter & D'Almeida 143; Eubank, 191.

A quite common fern in deeply shaded forest areas, in humid black soil among decaying leaf mould.

SPECIMEN SEEN: M.R. Almeida – 778.

2. **Dryopteris sparsa** (D. Don) O. Kuntze, Rev. Gen. Pl. 2:813, 1891.
*Nephrodium sparsum* D. Don, Prod. Fl. Nepal. 6, 1825.
*Lastrea sparsa* (D. Don) Moore, Index Fil. 87, 1858; Bedd., F.S.I., 36, t. 103, Handb. 252; Gray, 376; Birdwood, 432; Blatter & d'Almeida, 144.

Found near the waterfalls in shady places.

SPECIMEN SEEN: A. Dhanraj – 413.

3. **Dryopteris odontoloma** (Moore) C. Chr., Acta Hort. Gothob. 1:59, 1924.
*Lastrea odontoloma* Moore, Ind. Fil. 90, 1858; Beddome. Handb. F.B.I. 248, f. 128, 1883; Blatter & d' Almeida, 141.

This species has been reported from Kate's point, Mahabaleshwar, by Blatter & d'Almeida (1922). We have not been able to locate it in the field as well as in any herbarium.

*Hypodematium* Kunze

1. **Hypodematium crenatum** (Forsk.) Kuhn, V. Deck. Reis. bot. 3(2): 37, 1879.
*Polypodium crenatum* Forsk., Fl. Aegypt. Arab. 185, 1775.
Lastrea crenata (Forsk.) Bedd., Handb. F.S.I. 258, 1883; Blatter & d'Almeida, 147.

Found on old walls and on old earthen embankments. It is also found lithophytic on rocky surfaces in shady places.

*Tectaria* Cav.

1. Margins almost entire or slightly crenate ............................................*I. macrophylla*
1. Margins serrately dentate.*I. macrodonta*

1. **Tectaria macrodonta** (Fee) C. Chr. in Index Fil. suppl. 3: 181, 1934.
*Saqenia macrodonta* Fee, Gen. Fil. 213, t. 24A, f. 1, 1852.
*Aspidium cicutarium* (non Swartz, 1803) sensu Bedd., Handb. Ferns British India, 220, 1883; Birdwood, 211; Blatter & d'Almeida, 132, f. 12; Eubank, 193 (non *Polypodium cicutarium* Linn., 1764).
*Saqenia coadunata* Wall. *ex* Bedd., F.S.I., 28, t. 81, 1863; Birdwood, 211; Gray, 376.
*Aspidium coadunatum* Hook. *et* Grev., Icon. Fil t. 202, 1831.

The commonest species found at Mahabaleshwar in shady places, in loose, black soils.

SPECIMEN SEEN: M.R. Almeida – 248.

2. **Tectaria macrophylla** (Sw.) Copel. *in* Phillippine J. Sci. Bot. 2:413, 1907.
*Aspidium macrophyllum* Swartz, Syn. Fil. 43 & 239, 1806; Blatter & d'Almeida, 133.

Known from only one collection from Mahabaleshwar.

SPECIMEN SEEN: N. Gunjathkar – 34 (Poona Univ. Herb).

POLYPODIACEAE

1. Sori acrostichold; fronds dimorphic ..................*Leptochilus*
1. Sori round; frond not dimorphic.........................................2
    2. Sori in a single row on either side of the midrib ..................... ...............................*Lepisorus*
    2. Sori scattered over entire frond ................*Microsorium*

*Lepisorus* Ching

1. **Lepisorus nudus** (Hook.) Ching, in Bull. Fan. Mem. Inst. Biol. Bot. 4: 83, 1933.
*Pleopeltis nuda* Hook. Exot. Fl. 1: 63, 1823.
*P. linearis* Moore, Ind. Fil. 346, 1862 (non Kaulf, 1824); Bedd., Handb. 346; Birdwood, 128; Blatter & d'Almeida, 170; Eubank, 191.

A common epiphytic fern all over Mahabaleshwar. This species develops fronds in monsoon which dry and curl after the rainy season. The rhizome remains dormant during summer. Common hosts for this epiphytic species are *Eugenia jambolana* and *Memecylon umbellatum.*

SPECIMEN SEEN: M.R. Almeida – 726.

*Leptochilus.* Kaulf.

1. **Leptochilus lanceolata** Fee, Arcost. 37, t. 47, f. 1, 1845.
*Gymnopteris lanceolata* Bedd., F.B.I. suppl. 26, 1876. *G. variabilis* var. *lanceolata*

Bedd., Handb. F.B.I. 429, 1883.
Birdwood, 127; Blatter & d'Almeida, 186.
Found near watercourses attached to rocks.
SPECIMEN SEEN: T. Cooke – s.n.

*Microsorium* Link

1. **Microsorium membranaceum** (Don) Ching, in Bull. Fam. Mem. Inst. Biol. bot. 4: 295, 1933.
*Polypodium membranaceum* Don, Prodr. Fl. Nepal. 2, 1825.
*Pleopeltis membranaceus* (Don) Bedd., Handb. Ferns Brit. India, 357, 1883; Gray, 376; Birdwood, 128; Blatter & d'Almeida, 172; Eubank, 191.

The commonest and most abundant fern at Mahabaleshwar. Every *Ficus racemosa* tree in Mahabaleshwar Bazar is covered with this species in monsoon. It grows on rocks and on roofs of old houses.

SPECIMEN SEEN: M.R. Almeida – 701.

(*Concluded*)

## NEW DESCRIPTIONS

# DESCRIPTION OF A NEW RASBORINE FISH, *ESOMUS MANIPURENSIS* FROM MANIPUR, INDIA[1]

RAJ TILAK AND SEEMA JAIN[2]

(*With two text-figures*)

A new rasborine fish belonging to the genus *Esomus* Swainson, collected from a stream near Imphal, Manipur is described and figure in this paper. The description of the new species extends the range of distribution of the genus *Esomus* to Eastern India as far as Manipur. Till date three species of genus *Esomus* are known from India.

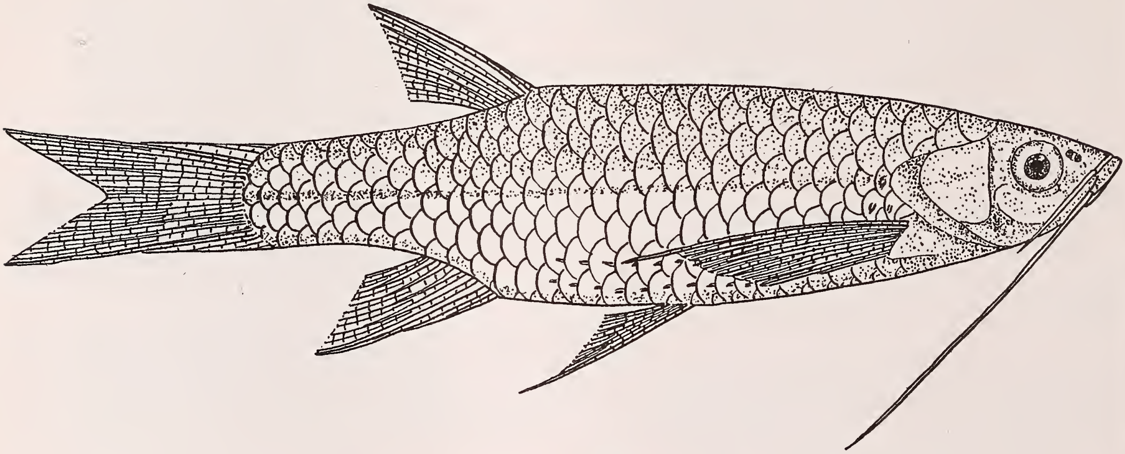

**Fig. 1. Lateral view of *Esomus manipurensis*, sp. nov.**

## INTRODUCTION

The recently collected material of the genus *Esomus*, from a stream near Imphal, Manipur has been studied and determined as a new taxon which has been named *Esomus manipurensis*. The species is described and figured. Two species of this genus are known so far from India, *E. danricus* (Hamilton) and *E. barbatus* (Jerdon). The present species is the third.

## DESCRIPTION

**Esomus manipurensis** sp. nov.
(Figs. 1-2)

B. III, D. 8 (II/6), P. 13 (I/12), V. 7 (I/6), A. 8 (III/5), Lat. 1. 30-31, Lat. tr. 5/1, Barbels 4, Predorsal scales 16.

Body oblong, slightly compressed. Mouth opening small and directed upwards. Jaws highly protrusible. Symphysial knob well- defined. Head small and its length 5.61-5.63 times in total length and 4.28-4.44 times in standard length. Snout small, length of snout 4.44-4.50 times and postor-

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[1] Accepted January 1988.

[2] zoological Survey of India, Dehra Dun.

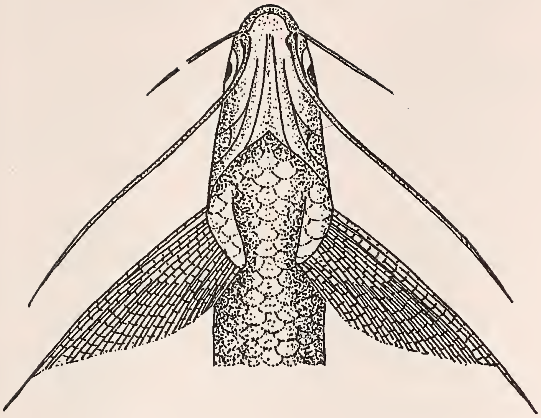

**Fig. 2. Ventral aspect of head and anterior part of body of *Esomus manipurensis*, sp. nov.**

bital head length 2.00- 2.12 times in head length. Diameter of eye 3.00-3.60 times in head length. 1.00-1.33 times in interorbital width and 0.67-0.83 times in length of snout. Depth of body 4.77-5.27 times in total length and 3.64-4.00 times in standard length. Width of body 12.63-14.57 times in total length and 9.63-11.40 times in standard length.

Lateral line double, with a gap equal to half width of scale between two lateral lines, incomplete, extending to the anal origin with one scale between the 1st lateral line and base of ventral fin. Barbels 4, rostral pair short and extending upto the posterior margin of the eye, maxillary ones long and extending beyond the ventral origin.

Dorsal fin commences beyond the ventral fins and in advance of the anal fin origin. It is nearer the base of caudal than the head. the last undivided ray equal to or longer than the head and its length 0.95-1.06 times in head length. Length of dorsal fin base 2.40-2.66 times in head length. While that of anal 2.25-2.35 times in the same dimension. The length of longest anal ray 0.90-1.00 times in head length. The length of anal fin base 0.88-0.94 times in length of dorsal fin base. Longest ray of pectoral fin is much longer than the head and extends far beyond the origin of ventral fin, its length is 0.60-0.67 times in head length and 0.77-0.83 times in distance between the origin of pectoral and ventral fins, length of ventral fin 0.90-0.95 times in head length and 0.90-1.05 times in distance between origin of pelvic and anal fins. Caudal fin forked and comparatively longer. Length of caudal fin 0.71-0.75 times in head length, 4.14-4.33 times in total length and 3.14-3.33 times in standard length. Least height of caudal peduncle 1.60-2.00 times in its length.

Predorsal and postdorsal distances 1.92-2.02 times and 3.75- 4.12 times respectively in total length and 1.47-1.54 times and 2.85-3.14 times respectively in standard length. Preventral and postventral distances 2.36-2.59 times and 2.63 - 3.00 times respectively in total length and 1.82-1.98 times and 2.00-2.29 times respectively in standard length. Preanal and postanal distances 1.73-1.82 times and 4.83-5.20 times respectively in total length and 1.31-1.39 times and 3.67-4.40 times respectively in standard length.

*Coloration:* A black lateral stripe or streak, fainting anteriorly.

*Types:* Holotype 1 ex., (58 mm in total length) Reg. No. NRS/ZSI/F. 434 Zoological Survey of India,, Dehradun, Locality: stream near Imphal, Manipur. Collector: Dr Raj Tilak. Date of Collection: 25- 12-1986. Paratypes: 4 exs. (50.5-52.5 mm in total length) Reg. No. NRS/ZSI/F. 435. Locality, collector and date of collection same as in Holotype.

## REMARKS

Two species of Esomus, namely *E.danricus* and *E. barbatus* are known from India (Hora and Mukerji 1928); *E. danricus* is found in Uttar Pradesh, Bihar, Bengal, Orissa, Assam and South India, and *E. barbatus* is only known from South India. The newly described species, *E. manipurensis* from Manipur differs from both these species in characters given in Table 1.

The newly described species, *Esomus*

TABLE 1

COMPARISON OF CHARACTERS OF THE INDIAN SPECIES OF THE GENUS *Esomus*

| Characteristics | | *E. manipurensis* sp. nov. (Hamilton) | *E. danricus* (Jerdon) | *E. barbatus* |
|---|---|---|---|---|
| 1. | Head length in total length | 5.61-5.83 | 4.35-5.40 | 4.30-4.58 |
| 2. | Head length in standard length | 4.28-4.44 | 3.35-4.13 | 3.40-3.76 |
| 3. | Eye in head length | 3.00-3.60 | 3.30-4.13 | 4.38-4.44 |
| 4. | Depth of body in total length | 4.77-5.27 | 4.93-5.92 (5.46) (5.46) | 6.25-6.61 |
| 5. | Depth of body in standard length | 3.64-4.00 | 3.71-4.57 | 5.23 |
| 6. | Snout in head legnth | 4.44-4.50 | 3.40-4-57 | 4.25-4.40 |
| 7. | Eye in snout length | 0.67-0.83 | 0.78-1.14 (0.96) | 1.00 |
| 8. | Length of longest dorsal ray in head length | 0.95-1.06 | 1.04-1.55 | 1.21-1.25 |
| 9. | Length of pectoral fin in head length | 0.60-0.67 | 0.67-0.89 | 0.89-1.00 |
| 10. | Length of pelvic fin in head length | 0.90-0.95 | 1.00-1.53 | 1.34-1.54 |
| 11. | Caudal in total length | 4.14-4.33 | 3.80-5.00 (4.39) | 4.77-5.70 |
| 12. | Lateral line | Double, incomplete extending to origin of anal fin, 30-31 scales | Single, incomplete piercing 4-6 scales, 28-29 scales | Single, complete 31-32 scales |
| 13. | Lateral transverse | 6(5/1/2+1/2) | 8(5/3) | 7(5/2) |
| 14. | Predorsal scales | 16 | 18 | 17 |
| 15. | Maxillary barbels | Cross ventral origin | may or may not extend to ventral | Cross pectoral origin |
| 16. | Number of branched pectoral rays | 12 | 10 | 11 |
| 17. | Number of branched pelvic rays | 6 | 7 | 8 |
| 18. | Coloration. | Lateral black streak, fainting anteriorly base. | Lateral band extending from eye to caudal | No colour band |

*manipurensis*, remotely resembles *E. metallicus* described by Ahl (1923) from Siam but a detailed comparison with this species can be made only after the material of *E. metallicus* is available for study.

The description of the new species extends the range of distribution of the genus *Esomus* to Manipur. So far no species of *Esomus* has been reported from Manipur (Hora 1921, Menon 1950, Menon 1952).

ACKNOWLEDGEMENTS

We are grateful to Director, Zoological Survey of India, Calcutta and Mr. Gonchandra Sharma, Research Scholar, Department of Life Sciences, Manipur University, Kanchipur, Imphal, for his help in collection of the material.

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# *INDOGRAMMODES* GEN. NOV. FOR *POLYGRAMMODES PECTINICORNALIS* (GUENEE) (PYRAUSTINAE: PYRALIDAE: LEPIDOPTERA)[1]

JAGBIR S. KIRTI AND H.S. ROSE[2]

(*With four text-figures*)

The species *Polygrammodes pectinicornaliss* (Guenee) known from certain Indian localities is assigned to a new genus *Indogrammodes*. The generic characters of the new genus are defined.

## INTRODUCTION

During the course of studies on the taxonomy of Indian species of the subfamily Pyraustinae, four individuals of *Polygrammodes pectinicornalis* (Guenee) were collected from Jatinga (North Cachar Hills) and Kohima (Nagaland). From the study of relevant literature, as quoted under remarks, it is felt that the generic assignment of this species has remained indeterminate for the past many years. In order to standardize its status, a new genus *Indogrammodes* has been proposed and the generic characters have been defined.

### Genus **Indogrammodes** gen. nov.

Type-species: *Botys pectinicornalis* Guenee

*Pectinicornalis* Guenee, Delt. & Pyral., p. 326 (1854) (*Botys*) (Zentr.-Indien). — Walker, Cat. Lep. Het. Brit. Mus., 18, p. 647 (1859) (*Botys*). — Lederer, Wien. Ent. Monatschr., 7, p. 391 (1963) (*Pachynoa*). — Walker, Cat. Lep. Het. Brit. Mus., 34, p. 1481 (1865) *(Pachynoa)*. — Swinhoe, Proc. Zool. Soc. Lond., p. 875 (1885).

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[1] Accepted March 1988.

[2] Department of Zoology, Punjabi University, Patiala 147002, Punjab (India).

(*Pachynoa*). — Swinhoe, Proc. Zool. Soc. Lond., p. 875 (1885). (*Pachynoa*). - Swinhoe & Cotes, Cat. Moths India, 5, p. 641 (1888) *Pachynoa*). — *Hampson, Fauna Brit. India Moths, 4. p. 398 (1896) (Pachynoa)*, Proc. Zool. Soc. Lond., p. 197 (1899) (*Polygrammodes* [*Pachynoa*]). — Swinhoe, Cat. Lep. Het. Oxford Mus., 2, p. 524 (1900) (*Pitacanda*).

Labial palpus porrect and rostriform, exceeding head by the length of latter; second segment moderately scaled; third short, with a pointed tuft of scales in front. Maxillary palpus filiform. Antenna of male modified, flagellum with 10-12 basal segments dilated, then pectinated for most of its length and heavily ciliated at distal end; simple in female. Fore wing with discal cell excatly half the length of wing; vein R2 originating from slightly before anterior angle of cell, apposed to $R_{3+4}$; stalk of $R_{3+4}$ as long as free parts of $R_3$ and $R_4$; $R_5$ strongly curved and approximated to $R_{3+4}$; $M_1$ from anterior angle of cell, thick at base and slightly curved; $M_2$, $M_3$ and $Cu_1$ approximated basally; anal loop weak. Hind wing with discal cell less than half the length of wing; veins Rs and $M_1$ shortly stalked; $M_2$, $M_3$ and $Cu_1$ from posterior angle of cell, the former two approximated at base. Tibiae with outer spurs half the length of inner spurs.

*Male genitalia:* Uncus very long, curved, dilated at tip, the later setose with hair-like setae; gnathos absent; tuba analis half the length of uncus; subscaphium strongly sclerotized; tegumen broad; vinculum narrow, V-shaped; saccus narrow. Valva short and broad; costa strongly inflated; sacculus well defined; harpe prominent, curved upwards and spine-like at tip. transtilla triangular; juxta hammer-like. Aedeagus with one of its walls sclerotized and the other membranous; vesica armed with a strongly sclerotized rod-shaped cornutus in middle.

*Female genitalia:* Corpus bursae bag-like, more or less oval, well sclerotized; signum wanting; ductus bursae long, narrow posteriorly and with a collar-like thickening at distal end; anterior apophyses long and narrow, dilated near bases; posterior apophyses short and thin; ovipositor with densely setose lobes.

### **Indogrammodes pectinicornalis** (Guenee) comb. nov.

(Figs 1,2, 3, 4)

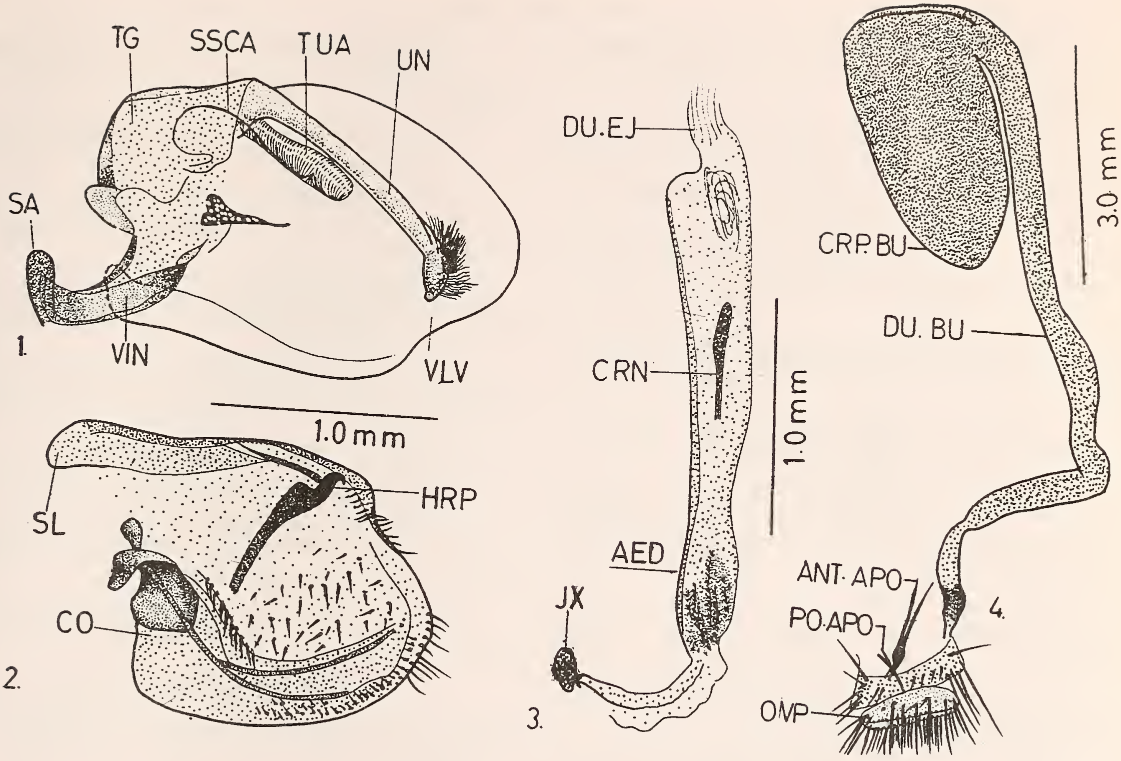
Guenee, 1854, Delt. & Pyral., 1854: 326 (*Botys*).

*Material Examined:* Assam: North Cachar hills, Jatinga, 3 Males, 12-4-1982. — Nagaland: Kohima, 1 Female, 28-9-1983.

*Distribution:* Bombay, Poona and Bengal.

This species was described for the first time under the genus *Botys* Latreille by Guenee (1854). The same arrangement was also followed by Walker (1859). Lederer (1863), however, proposed a new combination for this species and referred it under genus *Pachynoa* Lederer, an arrangement followed by Walker (1865), Swinhoe (1884), Swinhoe and Cotes (1889) and Hampson (1896). Hampson (1899) in a subsequent publication placed this species under the genus *Polygrammodes* Guenee and synonymised the genus *Pachynoa* along with two other genera *Aphytoceras* Meyrick and *Pitacanda* Moore. The use of the name *Polygrammodes* along with the synonymisation proposed by Hampson, did not result in any change in the catalogue by Klima (1939). Sevastopulo (1938) collected the species under reference from Calcutta and described it under genus *Pachynoa*, whereas Bradley and Shaffer (1969), Mandal and Bhattacharya (1980) thought it well to refer this species under *Polygrammodes.*

A critical study of literature reveals that the type-species of the genus *Pachynoa* (type-species: *thoosalis* Walker not *walkeri* as considered by Whalley 1962) and *Polygrammodes* (type-species: *runicalis* Guenee) are not congeneric (Munroe 1958b). Besides this generic name, the name *Aphytoceras* has already been revived and used in various publications by Munroe (1950, 1958a, 1958b, 1959, 1960, 1968, 1977), Munroe and Mutuura (1969) and Whalley (1962). However, the genus *Pitacanda* Moore, another synonym of *Polygrammodes* has been considered a synonym of *Pachynoa* by Munroe (1958b).



Figs. 1-4. *Indogrammodes pectinocornalis* (Guenee). 1-3: male genitalia; 4: female genitalia.

*Abbreviations:* AED: Aedeagus, ANT.APO: Anterior apophyses, CO: Costa, CRN: Cornuti, CRP.BU: Corpus bursae DU.BU: Ductus bursae, HRP: Harpe, JX: Juxta, OVP: Ovipositor, PO.APO: Posterior apophyses, SA: Saccus, SL: Sacculus, SSCA: Subscaphium, TG: Tegumen, TU.A.: Tuba analis, UN: Uncus, VIN: Vinculum, VLB: Valva.

The species under reference fails to go under *Polygrammodes* and other allied genera, namely *Pseudopolygrammodes* Munroe and Mutuura, *Polygrammopsis* Munroe, *Pachynoa* Lederer and *Aphytoceras* Meyrick and hence it requires a new genus for its appropriate placement. Accordingly, a new genus *Indogrammodes* is being proposed for this particular species. The diagnosis of the new genus is given in detail. The present genus is close to *Pachynoa* but differs from it in the structure of labial palpi, antennae, tibial spurs, venation of forewing and valvae of male genitalia.

The reporting of the species *pectinicornalis* from northeast India is a new record.

## ACKNOWLEDGEMENTS

We are grateful to Dr B.K. Tikader, Director, Zoological Survey of India, Calcutta, Mr Partap Singh, Forest Entomologist, Forest Research Institute, Dehradun, and Mr M. Shaffer, Pyralid specialist, British Museum (Natural History), London, for their help rendered during comparison of the species. The financial help provided by the University Grants Commission, New Delhi during the present studies is heartily acknowledged.

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## *SACCOLOMA CHARTACEUM* - A NEW SPECIES[1]

G. BHADRAN NAIR

Georg Friedrich Kaulfuss (1820) described the fern genus *Saccoloma* based on the species *elegans* which Chamisso collected from Sello, Brazil, on his voyage around the world. Later some pteridologists added more species to this monotypic genus, while Copeland (1947) segregated this into *Saccoloma* and *Orthiopteris* and all species except *elegans* were included in the new genus *Orthiopteris.* Tryon (1962), based on morphological studies on species, referred to *Saccoloma* and *Orthiopteris,* concluded that the principal differences between the two genera, as pointed out by Copeland, are not significant enough for generic separation. He recognised eleven species (with some reservation) under the genus *Saccoloma*; Nair (1987) supported Tryon in the generic circumscription of *Saccoloma* and only recognised 8 species under it. A critical examination of all herbarium sheets identified as *Saccoloma elegans* shows that there exist two morphologically distinct elements in the species so referred by authors.

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The species *elegans* Kaulf. is distinguished from the "new element" as follows:

Rhizome decumbent, mature plants always less than 60 cm in height, petiole straw-yellow, without persistant scale bases, pinnae base unequally obtuse, apex cordate acuminate, lamina thin herbaceous, veins always forked once or twice, never raised above the surface of the lamina; sorus submarginal, broader than long, distant; spores striate ..................... S. elegans

Rhizome erect, mature plants always more than a metre in height, petiole reddish-brown with spine-like persistent scale bases; pinnae base cuneate with crenulate margin, apex narrowly attenuated with deeply toothed margin, lamina chartaceous; veins rarely forked, very prominent, raised well above the surface of the lamina; sorus closer to the margin, separated by prominent septum; spores ribbed ........... S. chartaceum sp. nov.

### Saccoloma chartaceum sp. nov.

Rhizome mostly short erect, decumbent with age, 1-4 cm in diameter, scaly at the growing point, scales tufted, rarely remain attached at the older parts of the rhizome; scales basifixed, subpeltate to peltate, linear lanceolate, ovate to ovate-lanceolate, firm dark brown, marginal cells pale, 0.5 mm – 1.2 cm long, 0.3 – 0.8 mm broad; petiole close to densely clustered, 75-95 cm long, 0.9–1.4 cm in diameter at the base, stout, abaxially rounded, narrowly grooved above, margin of the groove pale yellow, slightly raised, continuous, the basal half of the petiole with dark spine-like, firm persistant scale base, above glabrous, lamina dark to pale- green, dark green on the dorsal side, pale on the abaxial side, about 110 cm long, one pinnate, ovate-oblong, thick chartaceous, apex always with confirm terminal pinnae, pinnae long elliptical to oblong-elliptical, 35-40 cm long, 3-3.5 cm broad, terminal pinna longer than the adjoining ones, pinnae base slightly unequal, cuneate with crenulate margin, apex narrowly attenuated with deeply toothed margin, 17-18 pinnae on one side, opposite, stalked, at the basal part, sub-opposite to alternate above; veins free, parallel rarely forked, very prominent below, reddish brown at the base, pale-yellow above; sori terminal on the veins, numerous, near the margin, separated by prominent septum, broader than long, indusium thin glabrous, fall short of margin, lamina margin folds back over to the sorus, receptacle flat, sporangia simultaneous numerous, long stalked; spores trilete, ovate- tetrahedral, ribbed, laesura thin, extends to the margin, spores 48-52 m in diameter.

*Type:* Mexia, Y. 8429 (MICH) Parroquia de Concepcion, Playa Rica, Esmaraldas, Ecuador.

Rhizoma erectum, deinde decumbens, 1-4 cm in diam., ad apiceum aquamatum, partibus veteribus rare squamis affixis. Squamae caespitosae, basifixae, subpeltatae vel peltatae, lineario-lanceolatae, ovatae vel ovato-lanceolatae, solidae, atrobrunneae; cellulae margine pallidae, 0.5-1.2 x 0.3-0.8 mm; petiolus approximatus vel dense fasciculatus 75-95 cm longus, ad basim 0.9-1.4 cm in diam. et crassus, abaxiale rotundatus, insuper anguste sulcatus; sulcus ad marginem dilute luteus, leviter prominens, continuus; petiolus dimidio inferiore basibus squamis persistentibus firmis fuscatis spiniformibus, supra glaber; lamina dorsale atroviridis, abaxiale dilute viridis, c. 110 cm longa, chartacea, 1-pinnata, ovato-oblonga; pinnae longae ellipticae vel oblongo-ellipticae, 35-40 x 3-3.8 cm, ad basim leviter inequales, cuneatae, ad apicem anguste attenuatae, margines ad apicem profunde dentati, ad basim crenulati, pinnae in quoque latera 17-18, ad basim oppositae et stipitatae, suprae suboppositae vel alternatae; pinna terminalis ceteris longiore; venae librae, parallelae, rare furcatae infra prominentissimae; venae primariae infra rufobrunnaeae, supra dilute luteae; venae secondariae dilute luteae; sori in venis terminales, marginibus, numerosi; septa prominenta, latiora quam longiora; indusium tenue, glabrum, margini approximati, margine super sorum plicato; receptaculum planum; sporangia simultanea, numerosa, longe stipitata, sporae triletae, ovatae, tetraedricae, costatae; laesura tenuis, margini approximati; sporae 48-52 μ m in diam.

**Geographical distribution:** The species *Saccoloma elegans* Klf. has not been collected outside Brazil, while the morphologically closely related *S. chartaceum* is reported as very wide spread in the Americas. Interestingly this species has not been collected from the areas of distribution of *S. elegans. Saccoloma elegans*, though reported as common in Bahia and rare in other places, has not been collected since 1939. The species *S. chartaceum* is reported as very common in Panama and Canal zone, Columbia, Venezuela, Guianas, Ecuador, Peru and Bolivia, its distribution in Cuba, Jamaica, Haiti, Rep. of Dominica, Trinidad, Brit. Honduras, Honduras, Guatemala, Nicaragua, Costa Rica and Brazil, is reported as "Scattered or not at all common".

### ACKNOWLEDGEMENTS

I thank to the Directors and Keepers of herbaria (K, MICH, C, NY, U, B, BM and Z) for their kind co-operation and to Professor Kramer for providing assistance in the identification. I would like to thank Dr V.J. Nair (Scientist, Botanical Survey of India, Coimbatore) for Latin translation and Mr K.G. Ajithkumar and Mr K.P. Vijayakumar for assistance.

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# A NEW SPECIES OF GENUS *CREIGHTONELLA* COCKERELL, (HYMENOPTERA : APOIDEA : MEGACHILIDAE), FROM CENTRAL INDIA[1]

RAJIV K. GUPTA[2]

*(With seven text-figures)*

The genus *Creightonella* Cockerell, from India, is represented by 3 species, namely: *Albifrons* (Smith), *bellula* (Bingham) & *fraterna* (Smith), A new species *Creightonella mitchelli* has been described for the first time from Jabalpur (Madhya Pradesh). It has certain close affinities with *C. albifrons* (Smith).

Genus *Creightonella* Cockerell, 1908 (type-species *Megachile mitimia* Cockll.), was originally proposed as a subgenus for some African species of genus *Megachile* Latreille. Michener (1962) upgraded it to generic rank and later (1965), while working with old world Megachilidae, the recategorised numerous species of *Megachile* to *Creightonella.*

*C. albifrons* (Smith), *C. bellula* (Bingham) & *C. fraterna* (Smith) are the 3 representatives which inhabit Indian territories. The following combination of characters can distinctly separate the genus *Creightonella* from the rest of the megachiline genera:

Form large, parallel sided; integument black with golden- yellow or snowy-white pubescence.

MALE: Mandible six toothed with small incomplete cutting edges in second to fourth interspaces; mid and hind basitarsi much shorter and narrower than corresponding tibiae; claws simple; VIth tergum scarcely concave in profile, without

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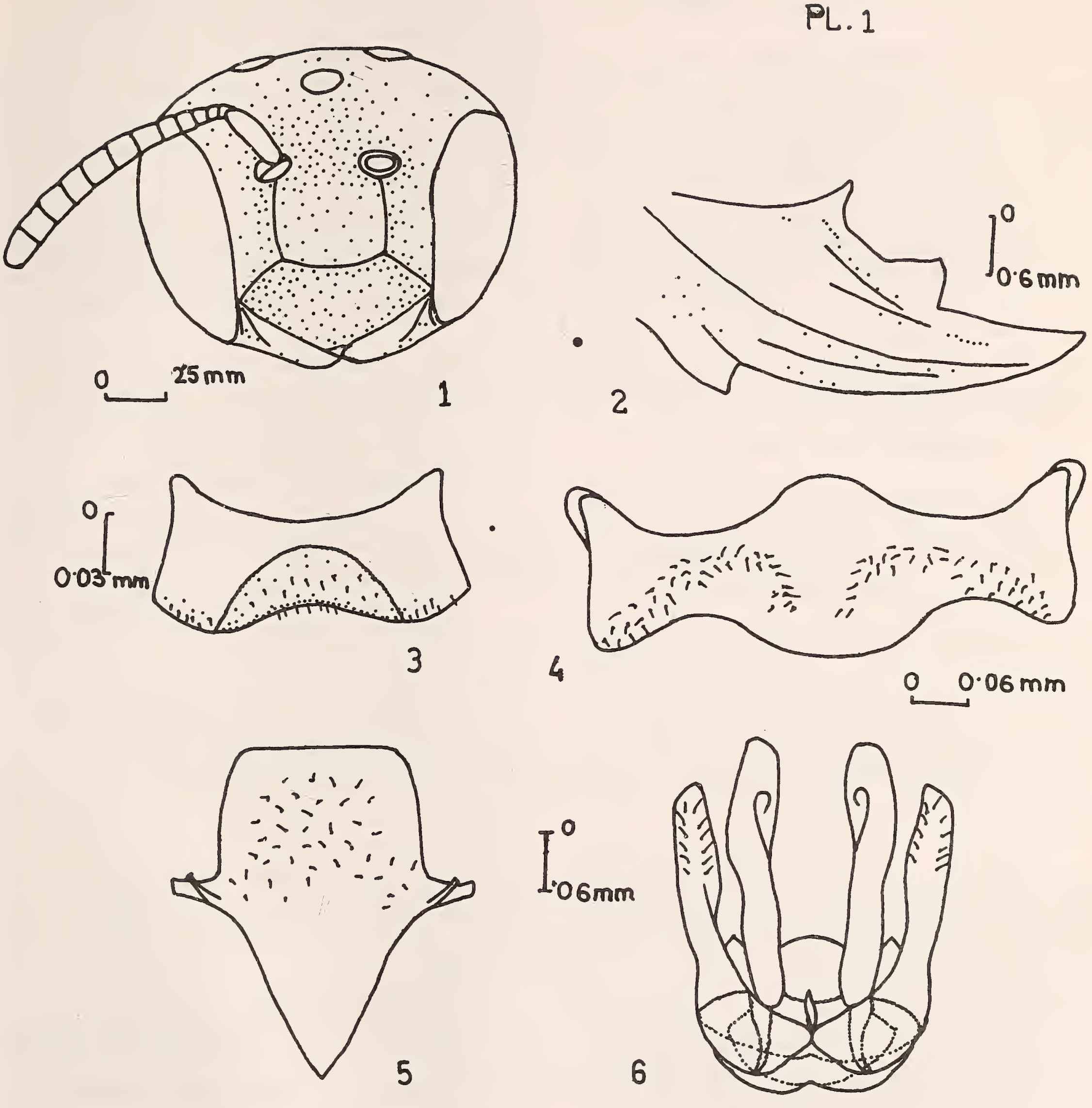
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Figs. 1-7. *Creightonella mitchelli* sp. nov.
Male: 1. Head, front view; 2. mandible; 3. tergum VIth; 4. tergum VIIth; 5. sternum VIth; 6. sternum VIIIth; 7. genitalia. (Dots on Figs. 1 & 2 indicate pubescence).

projecting apex, lateral margins nearly straight and surface with longer hairs; VIth sternum with scopal hairs over almost entire surface except apical margin; sterna lacking in any apical fasceae of pale hairs.

FEMALE: Mandible tridentate, lower margin with only a median projection; front coxa with blunt inner apical spine; front tarsi unmodified or slightly broadened; carina of VIth tergum broadly expanded with a mediolongitudinal ride and margin of carina with strong lateral teeth; VIIth tergum with prominent longitudinal median ridge, margin strongly convex; six exposed sterna; Vth and VIth sterna without membranous zones demarking medasternites; VIIIth sternum like a transverse plate, apex hairy and long spiculum; gonostyles of genitalia slender, apically not lobed.

### **Creightonella mitchelli**[3] sp. nov.

MALE: Integument black, ventral surface, legs, tergal margins, with redness; pubescence including on face & abdominal fasceae snowy white, tarsi with golden and on tibiae black.

Head slightly wider than median length; clypeal margin laterally angulate and medially invaginated; mid-facial groove absent; eye margin with a fine but elevated carina; genal maximum width equal to the eye width in lateral view, narrowed above, margin with slightly elevated carina; mandible tridentate, with a prominent median projection at lower margin.

Scutum broadly convex, pubescence white with few black erect hairs inbetween; pronotal carinate ridge produced anteriorly; first recurrent vein at the base and second one slightly far from the apex, of second cuboital cell of fore wing, wing colour pale-hyaline and veins black to brown piceous; second tarsus of fore leg much broadened; length of basitarsi of mid and hind leg more than half of the corresponding tibiae.

Basal tergal concavity margin carinate; apical fasceae of Ist to IVth terga confined to lateral patches, on Vth onwards discal pubescence appear as ferruginous hairs; VIth tergal carina not angulated with rest of the dorsal surface, with 6 acute teeth, dorsal longitudinal ridge diminishes quite before carina, either side of ridge shallowly concave, tergal apical margin below - invaginated, carinate and infasciate; VIIth tergum with a prominent longitudinal ridge from basal to apical margin, medially; basal sternum much expanded, margin shortly fringed and carinate, surface hairy; density of discal pubescence go on reducing from IInd to VIth sternites; margin broadly outcurved in IInd, straight in IIIrd and IVth and medially invaginated in Vth sternite; marginal fasceae increases in length upto Vth but lacking at the medial invagination of Vth sternum; VIth sternite: exposed, apical margin acutely outcurved, infasciate, laterally confined gradulus 'hairy'; VIIth sternite: apical margin entirely produced to broad apical lobe, rim with minute but complete fringe as in VIth; apical margin of sternum VIIIth broadly invaginated, fringed but basal process prominently elongated.

Genital gonobase extremely narrow; gonostyli slender, diverging; stipites of penis somewhat parallel sided, exceeding gonoforceps in length; genital aperture wide.

*Measurements:* (in mm.): Total length 12.5; eye: length 2.01, lateral width 1.0; clypeus: median length 0.8, basal and apical widths 0.92 and 1.7; antennae: length of scape 0.55, pedicel 0.12, flagellar segments Ist 0.5, IInd 0.45, VIth 0.5 and XIth 0.51 and breadths of VIth 0.2 and XIth 0.3; labrum: median length 1.0, basal and apical widths 0.9 and 0.5; labial palpi: length of segment Ist 0.75 and IInd 0.6; scutum: median length and maximum width 1.6 and 2.7; total length of fore wing 7.25 and of radial cell 1.75; relative median widths of tergite Ist to VIth 1.5, 2.75, 2.7, 2.5, 2.01, 1.75.

FEMALE: not known.

*Material Examined:* Holotype Male, Nehru Park, Jabalpur (M.P.), 400' m.s.l., 23-5-1981. Coll Raju Gupta; Paratype 2 males; same data as for holotype (holotype at N.P.C., Division of Entomology. I.A.R.I., New Delhi, paratypes will be placed at the same museum, shortly).

FLOWER RECORD: *Helianthus* sp., *Chrysanthemum* sp., *Tegetes* sp.

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[3] After Late Dr T.B. Mitchell, Prof. Emeritus, Entomology, North Carolina State University, Raleigh, U.S.A.

### REMARKS

The new species closely resembles .*Creightonella albifrons* (Smith), however, *albifrons* distinctly differs from *mitchelli* in : interspace in between 2nd and 3rd mandibular tooth being wider, and the latter one being obtuse; wings apical half dark fuscous and basal half subhyaline; front tarsi simple and unmodified; apical fasceae on tergite Ist to IVth complete and continuous; carina of VIth tergum broadly rounded with 8 terminal obtuse teeth, medio-longitudinal ridge prominent up to the margin of carina; apical margin of sternite Vth not invaginated medially; in VIIIth sternite apical lobe rounded; gonostyli parallel sided and gonobase prominent.

### ACKNOWLEDGEMENTS

I wish to thank Dr. V.K. Tewari, Lecturer in Zoology, Agra College, Agra, for providing necessary facilities and to Drs. S.I. Farooqi and S.L. Gupta both Senior Scientists at Division of Entomology, I.A.R.I., New Delhi, for the extended cooperation, leading to the preparation of this manuscript.

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## A NEW SPECIES OF GENUS *ANTHOCOPA* LEPELETIER AND SERVILLE (HYMENOPTERA : APOIDEA : MEGACHILIDAE), FROM ORISSA, INDIA[1]

RAJIV K. GUPTA[2]

*(With six text-figures)*

*Anthocopa anonyma, A. cathena, A. indostana* (all by Cameron) and *A. matheranensis* Michener were earlier described from within Indian limits. *A. auriculata* a new species, has been described for the first time from Konark (Orissa). It has some close affinities to *A. indostana.*

The Genus *Anthocopa* Lepeletier and Serville in the strict sense of Michener (1941, 1944), was earlier represented by 4 species from India, namely: *anonyma, cathena, indostana* (all by Cameron 1904, described in genus *Megachile* Latr., from Deesa, Sind) and *Matheranensis* Michener (1966, from Pune). Before proceeding to the description of the new species, I wish to enumerate the distinct characteristics of genus-Anthocopa, which separate it from the closely related genera *Hoplitis* Klug and *Osmia* Panzer.

"Small, robust, black bees with dense pubescence cover on face, legs and mesosoma; scutellum normal in profile or slightly above to oblique (not so much as in *Osmia*), usually metanotum moves upto the upper longitudinal line of mesosoma; parapsidial lines linear and distinct; anterior face of mesepisterna not separated from the lateral one with a carina or ridge; legs with distinct arolia; pregradular area of second tergum broadly-shallowly concave transversely; gradulus of second tergum may be-

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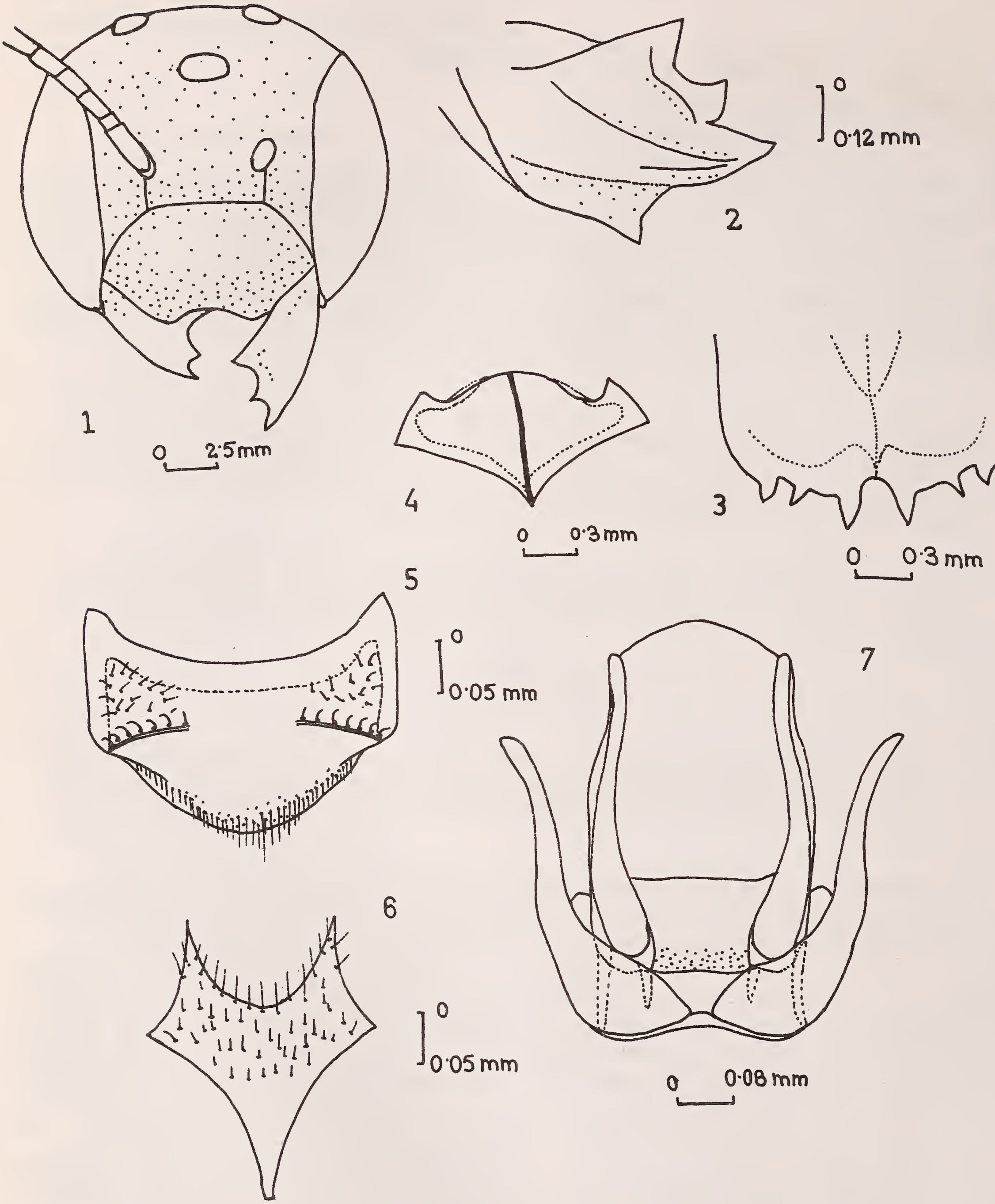
[3] After the golden pubescens of the body.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*Anthocopa auriculata* sp. nov.
Male: 1. Head, front view; 2. mandible; 3. sternum VIth; 4. sternum VIIth; 5. sternum VIIIth; 6. genitalia. (Dots on Figs. 1 & 2 indicate pubescence).

subcarinate; seventh tergum of male with conspicuous posterolateral teeth''.

### **Anthocopa auriculata**[3] sp. nov.

MALE: Integument black, feebly shining, legs brownish red, tegulae testaceous aple; eyes black; punctures fine and uniformly close; pubescence golden all over the body, face completely covered with hairs.

Head wider than the median length; inner eye margins strongly convergent below, straight and with prominent carina; clypeal margin laterally acutely angulate, outcurved but medially with a short concavity; vertex unevenly flat, ocellar triangle not elevated, occipital margin incarinate; maximum width of genae less than eye width in lateral view, feebly narrowed above; mandible tridentate, apical tooth much produced, lower margin with a basal process.

Scutum surface broadly convex, fine punctures inter- connected; pronotal ridge low & obscure; scutellar surface resemble scutum, posterior margin broadly rounded; tegulae with dense pubescence; first recurrent vein far from the base than the second one which is comparatively close to the apex, of second cuboital cell of fore wing; front coxae spinose, inner margins of all coxae incarinate; legs in general are normal, finely punctured but with remarkable long pubescence; tarsi unmodified, claws bifurcated with an arolium in between.

Basal tergal concavity margin semicarinate; apical margins fasciate from first to fifth tergites; carina of VIth tergum angulate from basal region, with a pair of blunt median spines and another pair at lateral extremities, acutely produced; apical margin of VIIth tergum strongly recurved and lyriate medially, spines are feebly markable at lateral extremities only; basal sternum broadly expended, fasciate, apical margin feebly invaginated medially; margins of IInd to IVth sternites slightly outcurved, all fasciate, but in Vth, margin at midline deeply incurved and fasceae at this incurve absent; sternite VIth and onwards eclipsed under Vth; margin of VIIIth not fringed, with very few setae on quadrate apical lobe.

Apices of gonocoxites divergent, setose and strongly angulate; stipites of penis valve globulate at apex.

*Measurements:* (in mm.): Total length 7.0; eyes: length 1.8, lateral width 0.92; clypeus; median length 0.52, basal and apical widths 0.52 and 1.3; antennal sockets; distance to clypeus, to median ocellus, to eye and to each other 0.55, 0.55, 0.3, 0.55; antennae: length of scape 0.45, pedicel 0.12, flagellar segments Ist 0.12, IInd 0.18, VIth 0.3 and XIth 0.32, breadths of VIth 0.18 and XIth 0.18; labrum: median length 0.6, basal and apical widths 0.6 and 0.5; labial palpi: lengths of segments Ist 0.28 and IInd 0.28; scutum: median length and maximum width 1.12 and 1.92; scutellum: median length of dorsal surface 0.5; fore wing: length of radial cell 1.25 and total length 4.9; relative widths of tergite Ist to VIth 1.25, 1.9, 2.05, 2.12, 2.12 and 1.4.

FEMALE: not known.

*Material examined*: Holotype Male, Konark (Orissa), m.s.l. 16. 8. 1981, Coll. Rajiv K. Gupta, (on wing); Paratype 1 Male same data as for holotype (holotype at N.P.C., Division of Entomology, I.A.R.I., New Delhi, Paratypes will be placed at the same museum, soon).

#### REMARKS

The new species is quite separate from *matheranensis* (very long proboscis, reaching up to hind coxae in repose), but *indostana* seems to be a close relative of *auriculata* sp. nov. in respect of the short proboscis, merely reaching upto front coxae in repose and the much produced apical tooth of tridentate mandible. Michener (1966) has expressed the probability of *anonyma and indostana*, being the same species on the basis of characters of head and thorax, since the type specimen of *anonyma* male lacks the abdomen. However, *indostana* distinctly differs from *auriculata* in: truncated clypeal margin; mandible without a basal process at lower margin; tegulae smooth; carina of VIth tergum with a prominent median projection and one on either sides feebly markable; tergum VIIth with distinct short spines at apical margin; stipites of genitalia not so broadly globulate at apices and gonostyli not angulate apically; body pubescence white and punctures on whole body not so uniformly fine.

ACKNOWLEDGEMENTS

I am grateful to Dr. H.N. Baijal, Head and Dr. V.K. Tewari, Lecturer, at Zoology deptt., Agra College, Agra, for providing necessary facilities and to Dr. S.I. Farooqi, Scientist S-3, Division of Entomology, I.A.R.I., New Delhi, for guidance in the preparation of the manuscript.

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# TWO NEW SPECIES OF HARPACTORARIA FROM SOUTHERN INDIA (HETEROPTERA: REDUVIIDAE:HARPACTORINAE[1]

DAVID LIVINGSTONE AND G. RAVICHANDRAN[2]

*(with two text-figures)*

Two new species of the genus *Sphedanolestes* Stal, namely *Sphedanolestes nigrocephala* sp. nov. and *Sphedanolestes bicolorous* sp. nov. from Southern India have been described and illustrated.

## INTRODUCTION

The genus *Sphedanolestes*, under the division Harpactoraria, includes species with head as long as pronotum and posterior lobe of the latter longitudinally impressed. Distant (1904 and 1910) recognised 19 species from the Oriental region, mostly from northern India and Burma: *S. stigmatellus*, *S. signatus*, *S. variabilis*, *S. aterrimus* and *S. fraterculus* are the five species so far known from southern India, mostly from Nilgiri Hills. At present three more species, namely *S. dives*, *S. indicus* and *S. pulchriventris* have been recorded for the first time in Southern India. Without any exception, all are alate, arboreal, and endemic to the tropical rain forests of this region. Now two more species have been added to the list of *Sphedanolestes* of this region.

### 1. **Sphedanolestes nigrocephala** sp. nov. (Fig. 1)

FEMALE: Length 7.5 mm; width across the abdomen 2 mm; macropterous; oblongly elongate, golden yellow; antennae, tibiae, dorsal surface of the postocular area in between and around the ocelli, clypeus, antenniferous tubercles, scape, posterior margin of the frons, eyes, dorsum of the abdomen behind the fifth segment, ventral surface of the genital segments, tibiae, tarsomeres and membrane, piceous; sternites of the fifth to seventh abdominal segments, canescent; head elongately ovate, anteocular area a little shorter than postocular area; ocelli raised, interocular sulcus deep and dark; collar short, cylindrical; first rostral segment not passing the eyes and the second joint longest, almost as long as postocular area; scape almost as long as fore femora; anterior lobe of pronotum globose, smooth, with a median longitudinal narrow fissure not passing the anterior margin of the posterior lobe; junction of both lobes deeply constricted; antero-lateral ang-

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[1] Accepted March 1988, Contribution no. 72.

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les with acutely pointed, obliquely directed tubercle; posterior lobe finely granulate; discal prominence moderately formed; postero lateral angles rounded; posterior margin slightly concave; scutellum broadly triangular without any trace of apical tubercle; fore and mid femora slightly incrassated, obscurely nodulose; membrane passing the abdomen, corium black apically.

In the Courtallam ecotype, the entire anteocular area and ocellar prominence remain black in both sexes.

This species resembles the species of *Cydnocoris* in its general appearance and closely resembles *Sphedanolestes* trichrous Stal, in the coloration of the head, antennae, abdomen and membrane. But it can be readily recognised from the latter by its bright golden yellow colour and conspicuous development of tubercles at the antero-lateral angles of the pronotum and non-

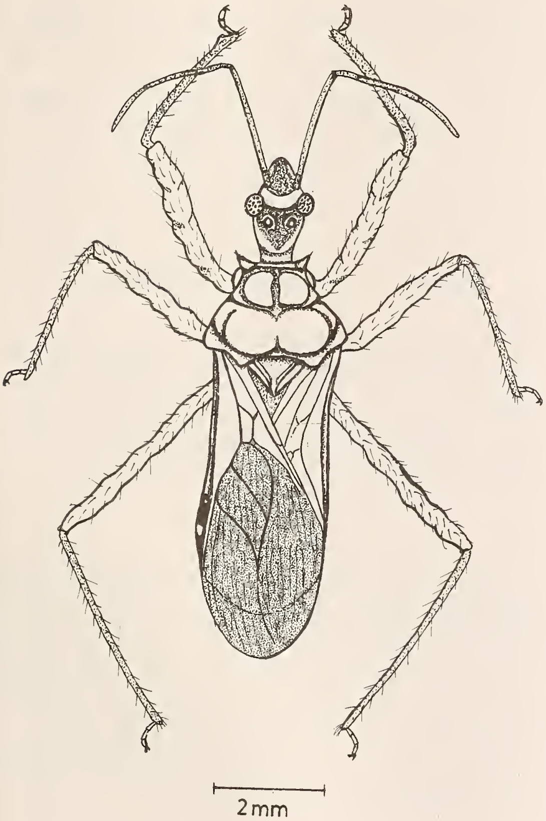

Fig. 1. *Sphedanolestis nigrocephala* sp. nov.

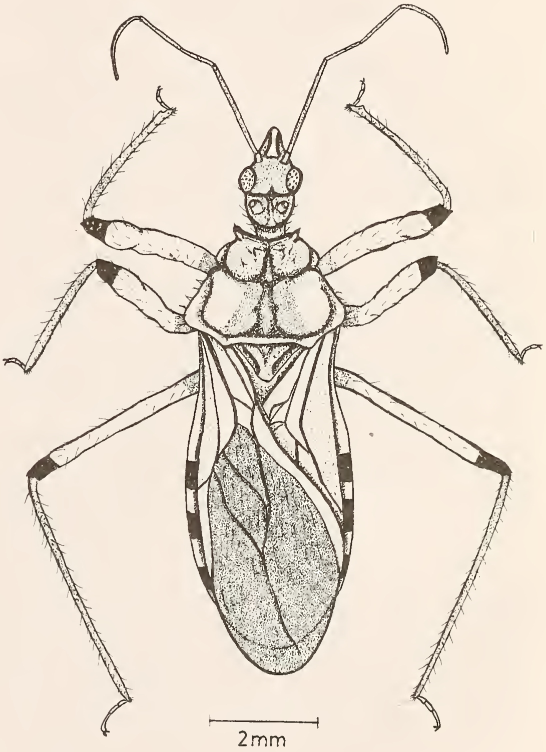

Fig. 2. *Sphedanolestis bicolourous*. sp. nov.

tuberculate condition of the broadly triangular scutellum.

TYPE INFORMATION: *Holotype:* Female, serial No. 121. *Paratype* one male, both pinned specimens deposited for the present in the reduviid collection of the Division of Entomology, Bharathiar University, Coimbatore, South India. Both specimens are arboreal, fast fliers, collected from underneath leaves.

COLLECTION INFORMATION: Specimens were collected from tropical Rain forest area near Servalar, Tirunelveli District, Tamil Nadu, on 2 October 1983 at elevation 250 m above MSL, temperature 33° C and humidity 52%.

### 2. **Sphedanolestes bicolorous** sp. nov. (Fig. 2)

FEMALE: Length 9 mm; width across the abdomen 4 mm; macropterous; ovate; stramineous; head, eyes, antennae, scutellum tibiae, thoracic sternites, spots on connexivum piceous; fourth to last abdominal tergites black; head ovate; anteocular and postocular areas subequal, ocelli, wide apart and elevated; postocular area globose with short cylindrical ochraceous collar; scape almost as long as the fore femora; first rostral segment reaching the eyes, second segment almost passing the entire postocular area; rostrum and maxillary lobes in front of eyes castaneous brown; anterior lobe of pronotum globose, much smaller than the posterior lobe; smooth with a median longitudinal furrow, not passing its posterior limit; tubercles of the anterolateral angles short and curved backward; posterior lobe griceous, finely granulate, lateral angles moderately expanded, discal prominence moderately developed, posterior margin slightly concave; scutellum broadly triangular, apically nontuberculate; hemelytra bronzy brown, corium trnasparent basally, opaque apically; membrane passing the abdomen; fore femora slightly incrassated sub-apically; castaneous brown, apically slightly constricted, black; mid and hind femora similar but not incrassated; abdomen stramineous, sternum with lateral longitudinal brown fascia; connexivum dorsally and ventrally stramineous, spotted black.

In some specimens, the anterior lobe and discal areas of the posterior lobe of the pronotum are piceous.

This species resembles the previous species *Sphedanolestes nigrocephala* in the coloration of the head, hemelytra and tibiae. But it can be readily recognised by the nature of scutellum, coloration of the pronotum, obscurely recurved tubercles of the antero-lateral angles of the pronotum and the femora being almost smooth without having any nodulose, appearance.

TYPE INFORMATION: *Holotype:* Female, serial No. 122. *Paratype* one male; both pinned specimens deposited for the present in the reduviid collection of the Division of Entomology, Bharathiar University, Coimbatore, South India.

COLLECTION INFORMATION: Specimens were collected from Tropical Rain forest, Yelagire Hills, North Arcot District, Tamil Nadu on 13 September 1948 at elevation of 1000 m above MSL, temperature 23° C and humidity 70%.

## ACKNOWLEDGEMENTS

We are grateful to the authorities of the Bharathiar University, Coimbatore, for providing facilities and the department of Science and Technology, New Delhi, for financial support and encouragement, Thanks are due to Dr. S.K. Tandon, Zoological Survey of India, Calcutta, for his assistance in comparing these specimens with the National Collection of Reduviidae.

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# A NEW SPECIES OF *COELOGYNE* (ORCHIDACEAE) FROM MANIPUR, INDIA[1]

T.K. Paul, S.K. Basu and M.C. Biswas[2]

*(With seven text-figures)*

During a recent floristic survey in the Imphal valley, Manipur, several interesting orchids have been collected by Dr J. N. Ghatak of Manipur University. A new species of *Coelogyne* Lindl., collected during the exploration, is described with illustrations.

**Coelogyne ghatakii** T.K. Paul, Basu et Biswas sp. nov.

*Coelogyne griffithii* Hook. f. affinis, sed differt inflorescentiis brevioribus (12-14 cm), floribus 6-8, parvioribus (1-1.5 cm diam.), viridiflavis, sepalis trinervis, labelli lobis lateralibus ovato-ogy, oblongis, carinis 2, columnaque late alata.

**Coelogyne ghatakii** sp. nov. (Fig. 1-7)

Epiphytic or sometimes lithophytic herb. Pseudobulb 5.5 x 2 cm, ovoid-oblong, 4-angled with 4 grooves, dark-green. Leaves 2, petioled; petiole 2-3 cm long, glabrous, channeled; lamina 10-15 x 2.5-3.0 cm, elliptic-lanceolate, apex acute to acuminate, entire, gradually tapering at base, dark-green, coriaceous, 6-7 nerved. Inflorescence *c* 12 cm long, erect; peduncle *c.* 6.5 cm long, shorter than the leaves, slender, glabrous, green, naked, raceme with 6 to 8 flowers, basal portion covered with overlapping distichous brownish glumes. Flowers open successively, pedicellate, 1-1.5 cm across, greenish yellow; pedicel 5-10 mm long, slender, erect. Sepals 3, spreading, subequal, oblong-lanceolate, acute, entire, glabrous, 3-nerved, 6-7 x 3 mm; petals 2, spreading, 6-7 x 0.5 mm, linear, entire, apex obtuse, glabrous, 1-nerved. Labellum *c.* 7 x 5 mm, deeply 3-lobed, glabrous, greenish yellow; lateral lobes 4 x 1.5 mm, ovate oblong, obtuse, entire with 2-3 brownish patches; midlobe 4.5 x 3.5 mm, subquadrate, recurved, retuse, narrow at base, base with a brown dot, entire, undulate, with 3-4 brown dots; keels 2, prominent on epichile extending near to the apex, yellowish, entire. Column *c.* 5 mm long, 1.5-2 mm across, winged on the upper part, wings serrate, light yellow; anther 1, *c.* 1.5 mm long and broad, light yellow; pollinia 4, *c.* 1 mm, oval, whitish yellow.

*Type: India:* Manipur, Imphal valley, 20th April 1988, *Ghatak* 2213a (Holotype : CAL; Isotypes: 2213b, c, d, Manipur Univ. Herb.).

*Fls. & Frts.* : April – June.

*Ecology*: This species grows on tall trees as well as on moss-covered rocks in the Imphal valley.

The new species has been recently collected in a remote area of Imphal valley. The fresh specimens were critically studied and it is found that the flowers are small and open successively in the inflorescence, i.e., only few at a time whereas the rest are still in bud-condition. The scape-base is naked but the base of the rachis has a series of distichous glumes and these characters are of the section *Ancipites* Pfitz & Kranzle. of the genus *Coelogyne.*

The new species is closely allied to *Coelogyne griffithii* Hook. f. of the above-mentioned section but differs in the characters tabled below: It is named in honour Prof. J.N. Ghatak of Manipur University, a leading plant taxonomist in India who collected this species.

## ACKNOWLEDGEMENTS

We are thankful to the Director, Botanical Survey of India, for all facilities. Thanks are due to Dr. N.C. Majumdar, Scientist-SC, Botanical Survey of India, for rendering the Latin translation and Mr. Saibal Bose for line-drawing of this new taxa. Thanks are also due to Dr B.D. Sharma,

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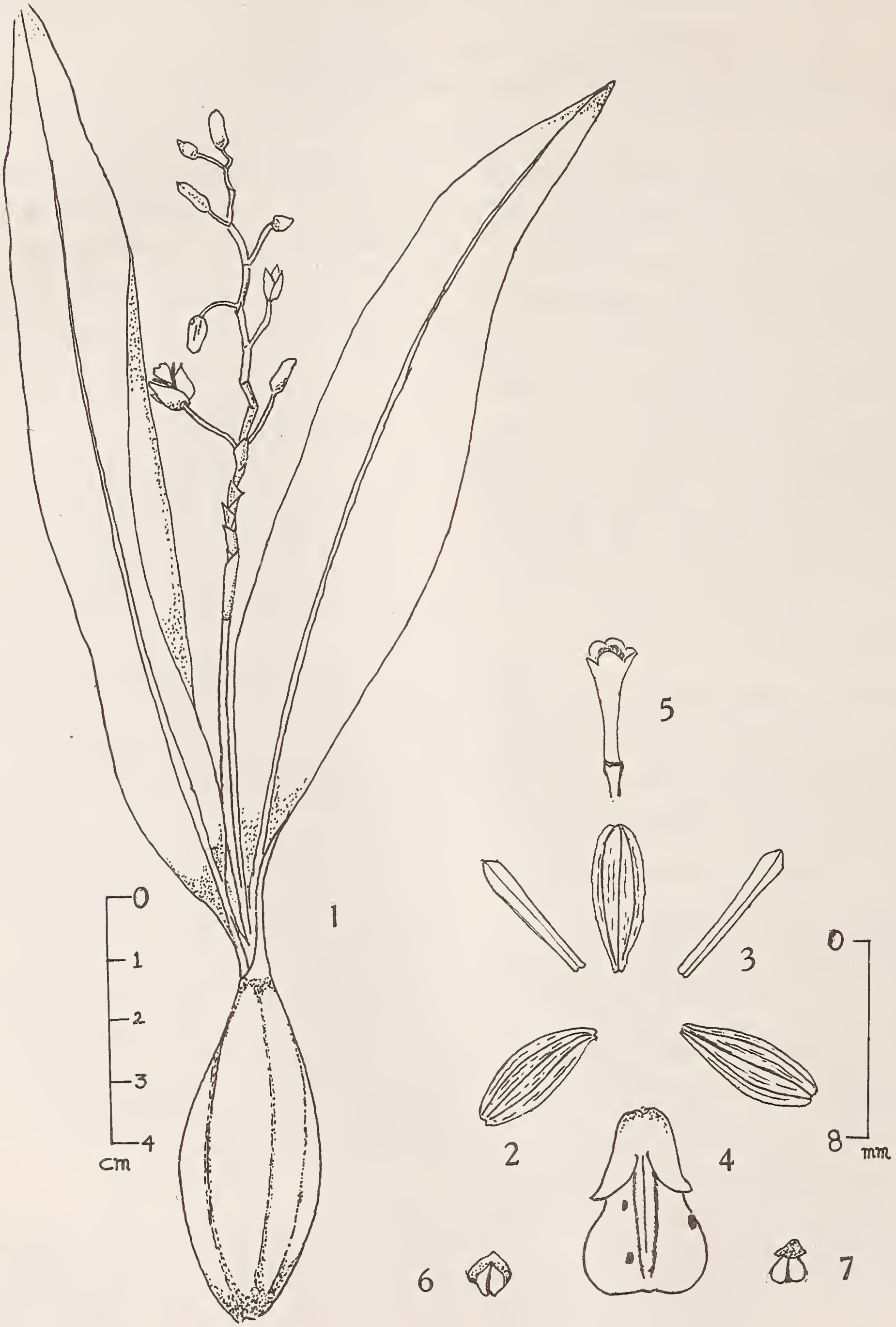
[1] Accepted August 1988.

[2] Botanical Survey of India, Howrah–711 103.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cm
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Figs. 1-7. *Coelogyne ghatakii* sp. nov.
1. Habit; 2. Sepal; 3. Petal; 4. Labellum; 5. Column; 6. Anther; 7. Pollinia.

Scientist-SE, Central National Herbarium, B.S.I., for kindly going through the manuscript.

| | *C. griffithii* | *C. ghatakii* |
|---|---|---|
| Leaf | : large (11.5-26.0 x 3-6 cm). | comparatively smaller (10-15 x 2.5-3 cm) |
| Inflorescence | : longer (15-34 cm), 6-18-flowered. | shorter (12-14 cm), 6-8 flowered. |
| Flowers | : 1.5-2 cm across, light brownish. | 1-1.5 cm across, greenish-yellow. |
| Sepals | : larger (1.0-1.3 x 0.3-0.6 cm), 5-nerved. | smaller (0.6-0.7 x 3 cm), 3 nerved. |
| Petals | : larger (10-13xl mm). Lateral lobes of labellum rounded, keels 5. | smaller (6-7 x 0.5 mm).. Lateral lobes of labellum ovate-oblong, keels 2. |
| Column | : narrowly winged. | broadly winged |

# A NEW LEPIDOPTERAN *INDOCALA* GEN. NOV. FROM INDIA (OPHIDERINAE: NOCTUIDAE: LEPIDOPTERA)[1]

H.S. Rose and A. Srivastava[2]

*(With five text-figures)*

*Indocala* gen. nov. has been proposed for the species *punjabensis* sp. nov. collected from Punjab (India). A brief account of the genitalia has been given along with adult description.

## INTRODUCTION

While considering the taxonomy of eighty species of the subfamily Ophiderinae, collected between August 1984 and September 1987, a homogenous sample consisting of seven individuals of a species could not be identified from the relevant literature (Hampson 1894, 1902, 1912, 1924, 1926). The species, in fact, belongs to a group of genera such as *Calyptra* Ochsenheimer, *Oraesia* Guenee, *Culasta* Moore and *Hypocala* Guenee. The examination of various morphological characters, especially the wing venation and genitalia, followed by their evaluation and comparison with the known genera indicated that the new species requires to be placed under a new genus. Accordingly a new genus *Indocala* is proposed for the new species *punjabensis*.

### Genus Indocala n. gen. nov.

Type-species: *Indocala punjabensis* sp. nov.

Labial palpus porrect, triangularly scaled; antenna simple, minutely ciliated. Forewing without areole, discal cell more than half the length of wing, $R_3$ and $R_4$ not stalked. Hindwing with discal cell slightly more than one-third the length, Rs and $M_1$, and $M_3$ and $Cu_1$ connate before anterior and posterior angle respectively. Male genitalia with uncus trifid, socii present, valva with well developed saccular extension, harpe

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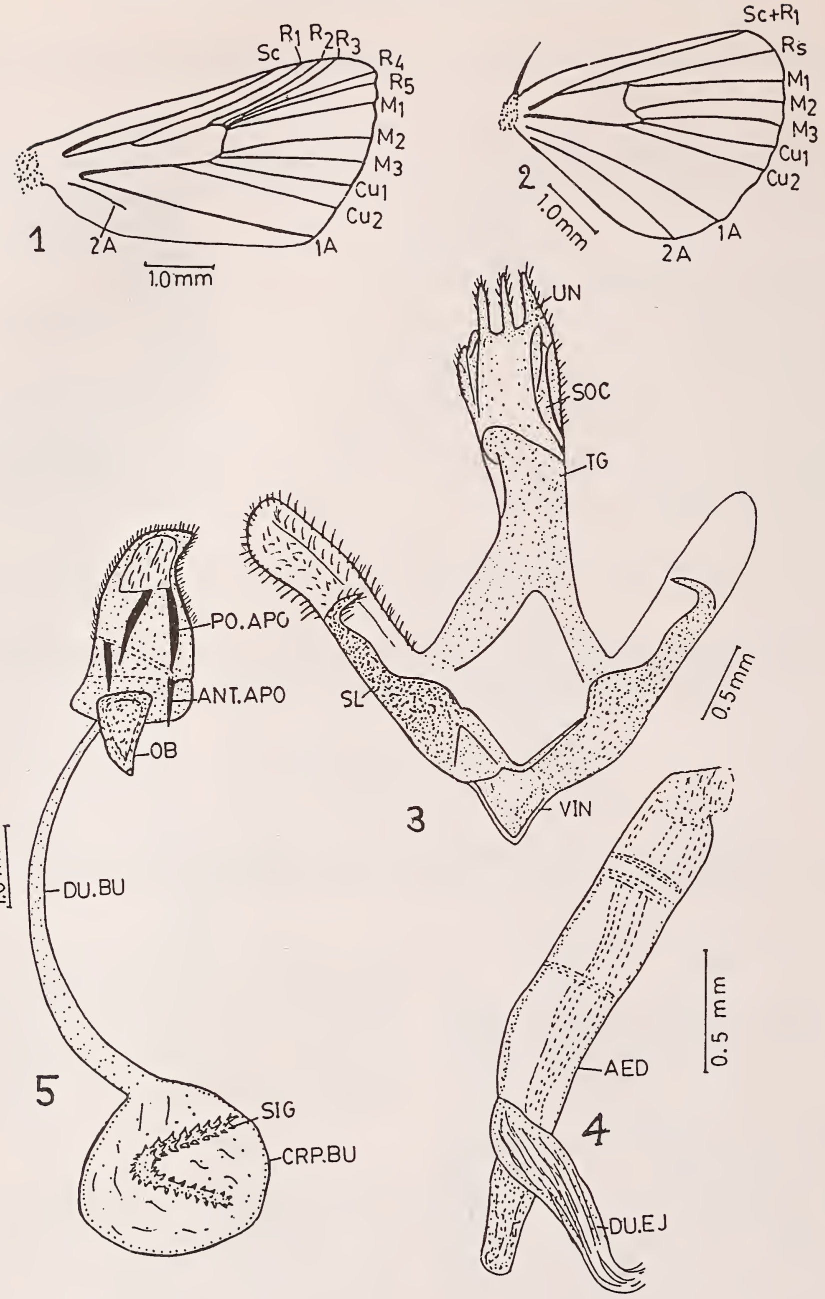
[1] Accepted August 1988.

[2] Department of Zoology, Punjabi University, Patiala–147 002, Punjab, India.


Sc
R1
R2R3
R4
R5
M1
M2
M3
Cu1
Cu2
1
2A
1A
1.0mm
Sc+R1
Rs
M1
M2
M3
Cu1
Cu2
2
1.0mm
2A
1A
UN
SOC
TG
PO.APO
ANT.APO
OB
SL
VIN
3
0.5mm
1.0mm
DU.BU
5
SIG
CRP.BU
AED
0.5 mm
4
DU.EJ

Figs. 1-5. *Indocala punjabensis* sp. nov.
1 & 2: Fore and hindwing; 3 & 4: Male genitalia; 5: Female genitalia.

*Abbreviations:* IA. First anal vein; 2A. Second anal vein; AED. Aedeagus; ANT.APO. Anterior apophyses; CRP.BU. Corpus bursae; Cu$_1$. First cubital vein; Cu$_2$. Second cubital vein; DU.BU. Ductus bursae; DU.EJ. Ductus ejaculatorius; M$_1$. First median vein; M$_2$. Second median vein; M$_3$. Third median vein; OB. Ostium bursae; PO.APO. Posterior apophyses; R$_1$. First radial vein; R$_2$. Second radial vein; R$_3$. Third radial vein; R$_4$. Fourth radial vein; R$_5$. Fifth radial vein; RS. Radial sector; SL. Sacculus; SOC. Socii, TG. Tegumen; UN. Uncus; VIN. Vinculum.

wanting. Female genitalia with ostium region well developed, corpus bursae with a pair of signa present.

### Indocala punjabensis sp. nov.

**Adult:** Head, thorax, tegula and patagium greyish; labial palpus porrect, triangularly scaled, brownish, third segment long, beak like; antenna simple, minutely ciliated; eyes naked, large, dark with rounded spots. Forewing with costal margin somewhat straight, apex more or less acute, outer margin uniform, cilia grey brown; inner margin straight, ground colour grey brown, irrorated with large number of dark spots; an indistinct double submarginal outwardly waved lines represented by dark specks; underside yellowish with pinkish tinge, postmedial and submarginal bands dark. Hindwing with costal margin straight, apex somewhat truncate, outer margin uniform, cilia yellowish with pink tinge, anal margin furnished with yellow-pinkish scales, ground colour dark fuscous with slight pinkish tinge, a distinct postmedial band, a pinkish elongate spot near anal angle; underside yellow with pink shade, a distinct half post- medial line, medial line indistinct represented by dark spots. Abdomen smoothly scaled, grey with reddish tinge. Legs clothed with reddish brown scales.

**Venation:** (Figs. 1 & 2). Forewing with discal cell more than half the length, $R_1$ from well before middle of cell, $R_3$ from just before anterior angle, $R_4$ and $R_5$ from anterior angle, $M_1$ from anterior angle, $M_2$ from a little above posterior angle, $M_3$ from posterior angle, $Cu_1$ from just before posterior angle, $Cu_2$ from two-third of cell. Hindwing with cell less than half the length of wing, $R_s$ and $M_1$ connate before anterior angle, $M_2$ from just above posterior angle, $M_3$ and $Cu_1$ connate, slightly before posterior angle, $Cu_2$ from three-fourth of cell.

**Genitalia:** (Male: Figs. 3,4). Uncus unique, trifid, uniformly sclerotised throughout, setosed; socii well developed, flap like, thin walled, finely setosed; tegumen well developed, uniformly sclerotised; vinculum narrow, V-shaped, sacculus well developed, with curved saccular extension; transtilla simple, membranous, juxta not sclerotised, simple; aedeagus broad, rod-like, uniformly sclerotised throughout the length, vesica with dents, specific cornuti wanting.

**Female:** (Fig. 5): Ovipositor lobes well developed, sclerotised, setosed; posterior apophysis broader and longer than anterior apophysis; ostium bursae sclerotised, vorticella or somewhat V- shaped; ductus bursae thin walled, long, transparent tube like; corpus bursae globular, thin walled; signum present (two rod-like structures having attached to a large number of spines).

Wing expanse (half): Male and female : 16 mm.

*Collection studied*: Holotype: Male, Punjab: Punjabi University, Patiala, 24-7-1987. Allotype: Female, same data as holotype, 24-7-1987. Paratype : 4 Males, 27-7-1987, 1 Female, 29- 7-1987, same data as above.

The species is distinct from other known Ophiderines in the absence of an areole in the forewing. The genitalia are also of different and possess unique modifications in respect of certain constituent parts. The uncus is exceptionally well developed and is represented by three finger-like processes besides a pair of flap-like socii. The saccular part of the valva is conspicuous because of the presence of a thumb-like saccular process. In addition to this a pair of signae is also present in the corpus bursae. The ostial region (ostium bursae) looks like a pouch and is shaped more or less like a vorticella. Hence, the new genus *Indocala* has been proposed for the species which has been named after Punjab state.

The new genus with its unique characters, is somewhat allied to genera such as *Hypocala* Guenee, *Calyptra* Ochsenheimer, *Oraesia* Guenee and *Culasta Moore, all having rostriform type of labial palpi. However, Indocala* gen. nov. differs from its closest genus *Hypocala* on the basis of the veins $R_3$ and $R_4$ of the forewing, which are not stalked as in the former genus. Apart from this, in the male genitalia the harpe is wanting and saccus greatly reduced, whereas, socii are present in both the genera.

ACKNOWLEDGEMENT

We wish to thank C.S.I.R., New Delhi, for providing financial assistance during the tenure of the project on noctuid moths.

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# AN UNDESCRIBED SPECIES OF *MUSSAENDA* L. (RUBIACEAE) FROM EASTERN HIMALAYA[1]

S.K. BASU AND T.K. PAUL[2]

*(with ten text-figures)*

*Mussaenda andersonii* S.K. Basu *et* T.K. Paul typified by *Anderson*163 from Sikkim is established as a new species. The new species is described and illustrated.

While studying the material of *Mussaenda* L. (Rubiaceae) in CAL we came across some interesting specimens collected by Simons, Anderson, King and others during 1862-1876. These specimens are from Darjeeling, Sikkim Himalaya and had been given a manuscript name by King, but this name does not seem to have been published. Again King remarked on two of these specimens "Same as 6250G Wall. Cat." Further he also sought the opinion of C.B. Clarke on the identity of these specimens and quoted on the specimens "CBC says = *M. wallichii* G. Don". But *M. wallichii* G. Don as cited by J.D. Hooker (1880) in Fl. Brit. India is a plant with persistent calyx. G. Watt ignored Clarke's identification and wrote on one of the fruiting specimens (C.B. Clarke? 255), "Fl. Br. Ind. remarks regarding *wallichii* calyx teeth persistent". But he was silent about the identity of that fruiting specimen. jayaweera (1963) revised the genus *Mussaenda* L. of India and Sri Lanka but may not have examined these specimens preserved in CAL.

Our studies reveal that these specimens neither match with *M. wallichii* G. Don nor Wall. Cat. 6250 G, i.e., *M. glabrata* (Hook.f.) Hutch. ex Gamble, nor do they match with any other known species of the genus *Mussaenda* L. and in fact represent a hitherto unrecognised species. They are therefore described here as a new taxon.

### **Mussaenda andersonii** sp. nov.

*M. frondosae* L. affinis, sed differt foliis sparsim pilosis, stipulis intus glabris, calycis lobis brevioribus (*c.* 3 mm longis), puberulisque, sepalis petaloideis glabrescentibus, corollaeque tubis brevioribus (1.9 cm longis).

Scandent shrub; young stem hirsute, older stems glabrate, blackish brown. Leaves opposite, elliptic, ovate to oblong, 4.6-11.2 x 2.1-6 cm, apex shortly acuminate or acute, base cuneate or ounded, upper surface sparsely hairy, sometimes hairs only along the veins and veinlets; primary lateral veins 6-8 pairs; petiole 0.5-1.0 cm

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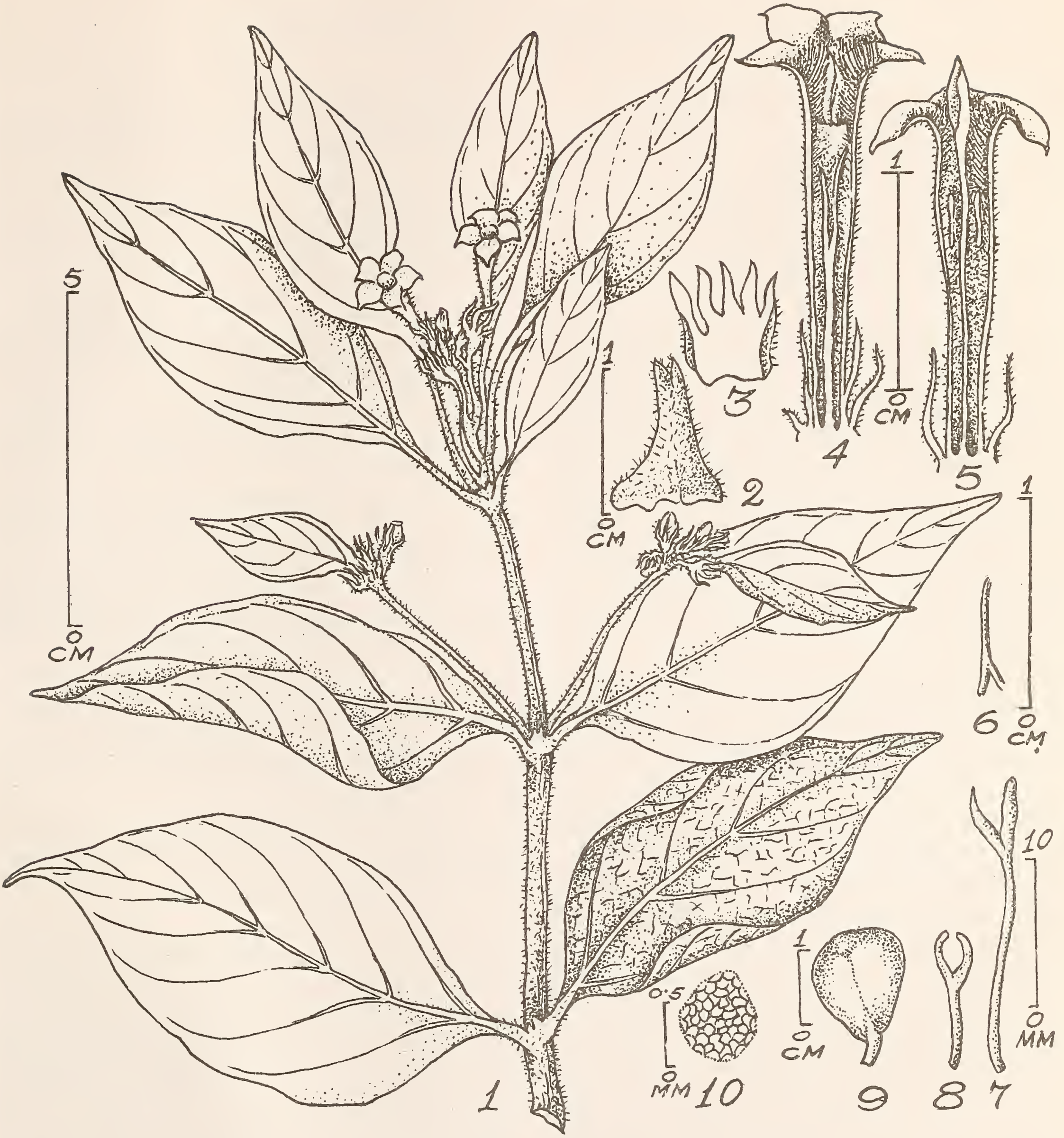
[1] Accepted September 1988.

[2] Central National Herbarium, P.O. Botanic Garden, Howrah–711 103.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Figs. 1-10. *Mussaenda andersonii* sp. nov.

1. Flowering twig; 2. Stipule; 3. Calyx lobes; 4. Longitudinal Section of short styled flower with tufted hairs at mouth and stamens in throat of the corolla tube; 5. Longitudinal Section of long styled flower with tufted hairs at mouth and stamens about half way on the corolla tube; 6. Dorsifixed anther; 7. Style of long styled flower; 8. Style of short styled flower; 9. Fruit; 10. Seed.

TABLE 1

DISTINGUISHING CHARACTERS BETWEEN *M. frondosa* AND *M. andersonii*

| | *M. frondosa* | *M. andersonii* sp. nov. |
|---|---|---|
| Leaf | : Primary veins 6-10 pairs, densely hairy | Primary veins 6-8 pairs sparsely hairy. |
| Stipule | : Inner surface hairy | Inner surface glabrous |
| Calyx | : Calyx lobes longer (6.5-15 mm long), hairy petaloid sepals hairy | Calyx lobes shorter (*c. 3 mm long), minutely pubescent,* petaloid sepals glabrescent. |
| Corolla | : Corolla tube longer (2-2.7 cm) long | Corolla tube shorter (1.9 cm) long. |

long, hairy; stipules 4 mm long, broadly triangular, bifurcate 1/4 - 3/4 their length, lobes straight, outer surface hairy, glabrous inside, deciduous. Inflorescence terminal or from leaf axils, dichotomously branched, pubescent, few flowered cymes; bracts and bracteoles trifid. Flowers heterostylous on stout pedicel, pedicel 2-3 mm long, pubescent. Calyx lobes 5, linear, *c.* 3 mm long, deciduous, outer side pubescent, inside glabrous or with few hairs; petaloid sepal creamy white, ovate or oblong-ovate, 2.5-5.5 x 1.3-3.2 cm, apex acute to subacute, base long or short attenuate or cuneate at base, glabrescent, 6-7 nerved, lower surface with few hairs on the nerves, petiole 6-10 mm long. Corolla tube 1.9-2.0 cm long, hairy on the outer surface, inner surface densely hairy upto the base of the anthers. Corolla lobes 4 x 2 mm, ovate, apiculate, outer surface hairy, papillate within. Anthers 4 mm and filaments 1 mm long in short styled form, in long styled form anthers 4.5-5 mm and filament 1.5 mm long, anthers linear, dorsifixed, bilobed at the base. Ovary 1-1.5 mm long, hairy, 2-locular; style and stigma lobes 6 mm and 3 mm long respectively in short styled form, 1.4 cm and 4 mm long in long styled form. Berry globose, *c.* 1 cm long and broad, sparsely hirsute to glabrous; seeds numerous, minute, *c.* 0.5 mm long and broad, reticulate, not spiny, brownish in colour.

*Holotype:* India, Sikkim, Kolwong, 9-5-1862, *Anderson* 163 (CAL).

*Fls. & Frts.* : May–Sept.

*Distribution:* Eastern Himalaya (Sikkim, Darjeeling).

*Specimens examined:* INDIA: Sikkim : Dungbo forest, 900–1200 m, 29-11-1875, *King s.n.* (CAL); Tangbob, 600 m, 12-5-1874, *s.l.* 574 (CAL); *Sine, loc. exact. Simons s.n.* (CAL). West Bengal, Darjeeling dist., above Mongpoo, 1680 m, Sept. 1874, Clarke (?) 255 (CAL).

*Mussaenda andersonii* S.K. Basu *et* T.K. Paul is allied to *M. frondosa* L. but differs as shown in Table 1. *M. andersonii* also differs from *M. laxa* (Hook. f.) Hutch. ex Gamble in having compact inflorescence.

The new taxon is named after T. Anderson, the first collector of this new species.

## ACKNOWLEDGEMENTS

We are thankful to the Director, Botanical Survey of India for all facilities. Sincere thanks and gratitude are also due to Dr D.B. Deb, ex-Deputy Director, Botanical Survey of India for his encouragements; Dr N.C. Majumdar for rendering the Latin translation and to Dr. B.D. Sharma, Deputy Director, Central National Herbarium, for going through the manuscript.

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# REVIEWS

SNAKEMAN by Zai Whitaker. The India Magazine Books, 1989. pp. 185, Rs. 195.

I have, pasted on the glass door of my book cabinet, a printed maxim that "Nothing is impossible to the person who won't listen to reason".

Not many people make it safely on the slippery road to success by balking convention. I know of only two in the field of natural history who did so and still made it to the top of the ladder, Salim Ali the noted Ornithologist, and Romulus Whitaker, the Snakeman.

This biography records Whitaker's rough road to success. I had met him many years ago for a hike through the forests of Kalakad Sanctuary in Tamil Nadu, a Sanctuary much loved by both of us. As Rom, after a long day's trek, settled down in the Dak Bungalow by changing into a 'lungi' and tying a string from window to window to hang up his clothes and his towel, I knew that he was fully assimilated and was, except for his unfortunate colour, as good an Indian as any native of the country.

Now a naturalised Indian, Rom has been the single major factor in the conservation of the reptiles of the subcontinent. The snakes particularly have been to a certain extent freed from the web of fear and superstition and from being exported abroad as dressed skins.

Rom's Madras Snake Park was largely responsible for this conservation movement. It is unfortunate that he was winkled out of the management of the Park. A self taught Herpetologist, he has very few peers in the field of ecology of the reptiles of India. This biography leads us through the early years of his snake collecting days in the USA to his return to India where he had studied as a boy, and his total involvement with the reptiles of the land and the people, the tribal Irulas, whose livelihood are the snakes. It is the fascinating story of goals achieved through sheer determination in the face of formidable obstacles.

The book has been written by Zai Whitaker with warmth and wry humour, and without any rancour for the many vicissitudes created for Rom by obtuse officials and others. The snakes, particularly the King Cobras, come alive in the descriptions of Rom's search in the subcontinent and the Andamans for these beautiful and vibrant animals. The book is pleasant reading throughout.

A book recommended not only for naturalists but also for those interested in the unusual in the human psyche.

J.C. DANIEL

MANAGEMENT OF NATIONAL PARKS AND SANCTUARIES IN INDIA by A. Kothari, P. Pande, S. Singh and D. Variava. Indian Institute of Public Administration, New Delhi, 1989. 289 pp. Rs 250/ US $ 40 (hardcover), Rs 150/ US $ 30 (soft cover)

The protection of nature is a very old tradition in India, deep- rooted in its cultural history. Sacred groves were established by hunter-gatherer societies several thousand years ago and they remain widespread today. As early as the 4th century BC, the establishment of forest reserves and special sanctuaries for wild animals was advocated in the Arthashastra, a manual of state- craft. Subsequently, many rulers set up and maintained reserves for hunting purposes. A number of these have remained largely intact and provided the basis of the present network of national parks and sanctuaries in India, which dates back to the early part of this century. Several sanctuaries in Assam, for example, were established in 1915 and subsequent years, while the first national park, Hailey (later renamed Corbett), was declared in 1936. The number of protected areas has risen rapidly in recent decades, from a modest 65 national parks and sanctuaries in 1960 to 472 by the end of 1989, extending over a total area of about 131,800 sq.km, or 4% of the country. In view of the numerous other pressures on land, especially forested land, this achievement of the state and central governments is remarkable.

Establishing protected areas is, however, only the first step: managing them in the face of mounting pressures is becoming an increasingly formidable task, demanding the reconciliation of wildlife interests with human needs and aspirations. Aware of many of the deficiencies in the existing network, the Government of India is to be congratulated for sponsoring a survey of its protected areas, the results of which are reported in 'Management of National Parks and Sanctuaries in India'. The survey, using a questionnaire approach, was carried out by the Environmental Studies Division, Indian Institute of Public Administration, under the direction of Shekhar Singh. Based on a sample of 249 protected areas, this study must rank as among the first of its kind, and the dedication and disciplined approach of the research team is evident in its meticulous and exhaustive treatment of the data. The report is divided into five sections, with chapters on legal status, natural resources, human activities, management and recommendations, supported by numerous tables of statistics which fill over half the volume.

Perhaps the most startling finding is that only 40% of national parks and 8% of sanctuaries sampled are legally designated; the rest have been initially notified and await completion of legal procedures. The boundaries of the great majority of protected areas, therefore, are not final — some may change during the settlement process. With some 56% of national parks and 72% of sanctuaries inhabited (at densities exceeding the national average of 2.5 persons per hectare in 10 sanctuaries), it is perhaps not suprising that legal procedures take on average three years and in some cases up to eight years to complete. Grazing, habitation, religious and agricultural rights or leases are among the most common issues requiring settlement.

Quite apart from the impact of fires, flooding, drought and water pollution, all of which are quantified in the report, protected areas are subjected to ever-increasing pressures from exploitation, both legal and illegal. Grazing of livestock, for example, is permitted in 39% of national parks and 73% of sanctuaries, but the incidence of illicit grazing is much higher in both cases. Similarly, timber continues to be legitimately extracted from 16% of national parks and 43% of sanctuaries. It would appear from the results of the survey that, in general, management is not equipped to deal with the scale of the problems that threaten many of India's protected areas. Only an estimated 50% of national parks and 31% of sanctuaries have management plans. Most of these are never approved by respective chief wildlife wardens, which means that budgets are seldom met in full or on time. Such shortcomings have previously been recognised. In 1985, for example, the Indian Board of Wildlife recommended that 15% of state forest department budgets should be earmarked for wildlife management at a time when expenditure on protected areas accounted for just over 2% of forest department budgets.

These are among the salient facts emerging from this study. Undoubtedly, it has its shortcomings and the authors readily acknowledge the fact that responses to the questionnaires have not been independently verified. This is a long process but is being addressed, with each protected area being visited as part of an ongoing project to produce a series of state protected area directories. In the meantime, the present report is warranted, enabling remedial action to be taken by policy and decision makers without unneccessary delay.

Overall presentation of the data is clear and concise, although statistics summarising some of the geographical and biological features of protected areas in Chapter 2 could have been presented in a more meaningful context. Data showing the frequency distribution of forest types within protected areas, for example, could have been accompanied by statistics summarising the national coverage of the different forest types, in order to identify gaps in the network. In the annexed section on international conventions, it is unfortunate that no mention is made of the World Heritage Convention, in which India is an active participant, with five natural properties designated under the Convention to date.

Such criticisms do not detract from the value of this report. Not only does the study provide a wealth of useful information on India's protected areas for wildlife managers, scientists and politicians alike, but it also serves as a model which could be usefully adopted in other countries.

MICHAEL J.B. GREEN

# MISCELLANEOUS NOTES

## 1. ON THE PRIMATES OF GUMTI SANCTUARY, TRIPURA

The Gumti Sanctuary in Tripura was notified in December 1988. It extends over 389.54 sq. km, of which approximately 70 sq. km has been inundated by a hydel dam. The sanctuary contains the following 6 species of primates — Hoolock Gibbon *Hylobates hoolock*, Phayre's Leaf Monkey *Presbytis phayrei*, Capped Langur *Presbytis pileatus*, Rhesus Macaque *Macaca mulatta*, Pig–tailed Macaque *Macaca nemestrina* and Stump–tailed Macaque *Macaca arctoides*.

I do not know of any area of equal size in the world where 6 distinct species of primates occur in one contiguous forest. In this regard, therefore, Gumti would be unique. It would be interesting to get feedback as to whether there are any such areas elsewhere, with such a diversity of primate species. I am given to understand that in a small island of about 20 hectares which has been formed due to the reservoir being created in Gumti as a result of the hydel project mentioned above, 3 species of primates now occur, namely the Hoolock Gibbon, the Leaf Monkey and the Stump–tailed Macaque. This must also be an unusual occurrence.

April 4, 1989. RANJITSINH

## 2. CRAB–EATING MACAQUE *MACACA FASCICULARIS* (RAFFLES) FEEDING ON HOUSE SPARROW *PASSER DOMESTICUS* (LINNAEUS)

On 21 August 1988, at 1430 hours in the Zoo at Alipur in Calcutta, I saw a male Crab–eating Macaque *Macaca fascicularis* (Raffles) run, jump and catch a House Sparrow *Passer domesticus* (Linnaeus) within its spacious enclosure. The monkey seized the bird with its left hand and with its right hand began plucking the feathers from the ventral side of the neck of the screaming bird. After clearing the feathers, the monkey bit on the cleared portion of the neck and tore off the skin and muscle of that region. The monkey ate the bird except for the feathers, claws and the intestine.

March 28, 1989 AJAY KUMAR MANDAL

## 3. SMALL MONGOOSE *HARPESTES AUROPUNCTATUS* FEEDING ON DROPPINGS OF NILGAI *BOSELAPHUS TRAGOCAMELUS*

With reference to the note "The Small Mongoose feeding on droppings of Nilgai" by S.K. Sharma in *J. Bombay nat. Hist. Soc. 85* (3): 611, I would like to add the following comments. Similar observations have been made at Keoladeo Ghana National Park, Bharatpur. However, further observations show that the Mongoose actually feeds on the pods of *Acacia nilotica* (Babul) present in the droppings of Nilgai *Boselaphus tragocamelus*. Sharma reports that the observation was made during the month of April, which is the peak fruiting period of *Acacia nilotica*. During this month Nilgai are frequently seen feeding on these pods. I am writing this note not to contradict his observation but to clarify that the mongooses actually feed on the *Acacia* pods present in the droppings of the Nilgai. It has been observed that they also feed on the pods present in the dung of cattle.

May 11, 1989. MD. NAYERUL HAQUE

## 4. ON THE DISTRIBUTION OF ASIAN HORSESHOE BAT *RHINOLOPHUS YUNANENSIS*

*(With a text-figure)*

This has reference to the article "A note on-Rhinolophus pearsonii Horsfield, 1851 and *Rhinolophus yunanensis* Dobson, 1872 (Chiroptera: Rhinolophidae)" by J.E Hill in *J. Bombay nat. Hist. Soc. 83* (Suppl.). I did not go through the article in detail, but some location errors caught my attention

On page 15, col. 2, para 3, the name of the locality "Tupai Mukh" should actually be "Tipaimukh". It is located in the Lushai Hills, which are presently in Mizoram and not Meghalaya as mentioned. Mishmi Hills are also not a part of Meghalaya, but are in Arunachal Pradesh. Khasi and Jaintia Hills are, of course, part of Meghalaya.

The errors are again repeated on pp. 16 and 17. The map (Fig. 1) shows the relative location of Meghalaya, Mishmi Hills and Tipaimukh. Moreover, on pp. 12 and 14 Meghalaya has been mentioned as being part of Assam, which it was only till 1972. Garo, Khasi and Jaintia Hills were part of Assam, but later became the separate state of Meghalaya.

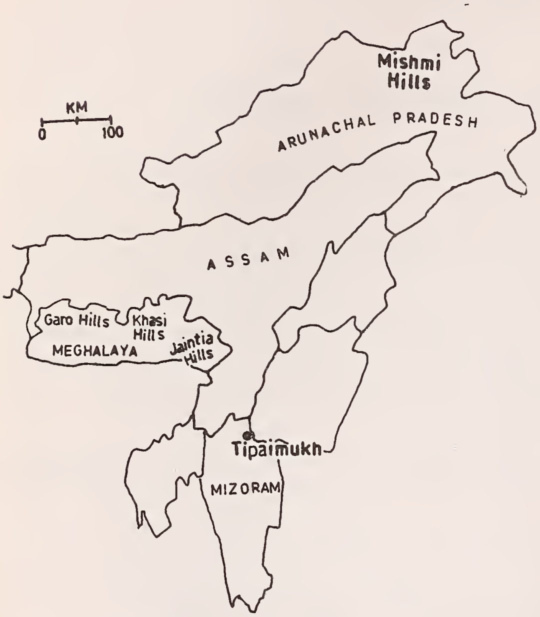

Fig. 1. Location of various places mentioned in the text.

April 20, 1989. ANWARUDDIN CHOUDHURY

## 5. ON THE STATUS OF MADRAS TREE SHREW *ANANTHANA ELLIOTI ELLIOTI*

The Wynad plateau in south India is *c.* 700 m above sea level and juts into the Malabar plains, ending rather precipitously on the Western Ghats. Wynad receives an average annual rainfall of *c.* 380 cm, mostly between May and August. It is criss-crossed by streams and supports a dense tropical forest, which until recently was nearly impenetrable. Destruction of forests for establishing Tea, Coffee and Cardamom plantations have now opened up most regions for human interference.

At the invitation of Prof. B.K. Nayar, Head of the Department of Botany, University of Calicut, I joined a team that undertook a three day survey of Wynad, Kerala, in February 1982 to assess the extent of possible destruction of the flora and fauna that could be caused by a proposed hydro-electric project. The study was sponsored and financed by the Kerala Electricity Board. The main areas covered were Mananthodi, Pakranthalam, Periya etc. On 15 February 1982, we were collecting plants and observing animals and birds. I walked alone a distance of about half a kilometre ahead of the team and reached a tarred road near the Arboretum (Silviculture Research Centre) of the Forest Department at about 0940 hrs.

At the side of the tarred road and adjoining this tree garden, I saw one Madras Tree Shrew *Ananthana ellioti ellioti* on the ground on and among the carpet of fallen dry leaves, mainly of Teak *Tectona grandis*. Even at first glance I could see that this animal was somewhat different from a squirrel or rat, and identified it as *Ananthana llioti ellioti*. I watched the animal for more than ten minutes and it appeared to me that it was not very disturbed by my presence at a very close quarters. Later on, when I picked up a stone and made as if to throw it, the shrew ran and climbed a Teak tree adjacent to a bamboo clump. I was not able to photograph the animal as I did not have a camera with me.

The mammal gallery in the Natural History section of the Prince of Wales Museum, Bombay, where I worked from 1969 to 1977, contains a single mounted and ex-hibited specimen of the Madras Tree Shrew. My familiarity with this specimen aided me to a great extent in identifying this animal in the field.

I think there is a lack of information on sightings or distribution of the Madras Tree Shrew. In this context, I feel that it would be worth reporting the sighting of this animal at Periya, Wynad, Kerala.

February 22, 1989. N.J. GEORGE

## 6. NECTAR FEEDING BY THREE–STRIPED PALM SQUIRREL *FUNAMBULUS PALMARUM* AT POINT CALIMERE WILDLIFE SANCTUARY, TAMIL NADU

The food of the Three–striped Palm Squirrel *Funambulus palmarum* (Linnaeus) includes the nectar of flowers (Prater 1980). In the Point Calimere Wildlife Sanctuary in Tamil Nadu, I noticed these squirrels extensively visiting *Rivea hypocrateriformis* flowers to drink the nectar. *Rivea hypocrateriformis* (Desr.) Choisy (Convolvulaceae) is a common vine forming mat–like thickets on shrubs and small trees and is an endemic in the flora of peninsular India. Its flowers are large, showy and fragrant, opening at dusk and closing at sunrise; the corolla is white, 7 cm across, salver–shaped; tube narrow, cylindical, 5 cm; stamens 5 with spinulose pollen grains and the style 5.5 cm with bifid stigma (Mathew 1982). Its peak flowering period in Point Calimere is December and January. They bloom en masse and I found 25 to 100 flowers in a plan in a day and one to many squirrels visiting every plant. They visit a flower, hold the thalamus of the flower with a forepaw and the corolla with the other forepaw, bite and tear the tube at the base whee the tube meets the tips of the calyx lobes, and lick the nectar that oozes out from around the ovary. They are very swift in action and finish this job within 30 seconds before moving on to another flower, and likewise attend most of the flowers of a plant.

Out of 462 flowers from 10 plants I examined on 30 December 1988, 306 flowers were attended by these squirrels. Though they attended large number of flowers they did not damage the flowers except in a few instances. Occasionally they plucked the entire flower and dropped it after drinking the nectar. They were feeding actively from 0600 to 0830 hrs. At around 0900 hrs the feeding activities ceased, as all the flowers had by then faded. There is every likelihood that the squirrels, while moving on the bush for feeding on the nectar, transfer pollen from one flower to another. It is interesting to note that the Three–striped Palm Squirrel extensively feeds on the nectar of *Rivea hypocrateriformis* flowers and possibly also plays a role in their pollination.

January 19, 1989. P. BALASUBRAMANIAN

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## 7. GRIZZLED GIANT SQUIRREL *RATUFA MACROURA* — DISTRIBUTION IN KUDIRAYAR

The Grizzled Giant Squirrel *Ratufa macroura* probably has a wider distribution than is believed. I have observed a few of these squirrels recently in the Kudirayar valley (25 km from Palani in Anna district of Tamil Nadu), which is situated on the eastern slopes of the Western Ghats below the Palani (Kodaikanal) Hills. It is hoped that the dam across Kudirayar stream, which is almost ready, will help the species, which is now mostly confined to the Kudirayar stream margin, to widen its base. There does not appear to be any serious threat to the squirrel's survival here.

April 11, 1989. PETER DAVIDAR

## 8. ELEPHANTS LIVING IN HARMONY WITH PEOPLE

It is quite surprising to witness the way in which the Elephants of Anakulam area interact with the local people. This area is a part of the Pooyamkutty reserve forest situated in Devikolam taluk of Idukki district, Kerala, and will be completely denuded if the proposed Pooyamkutty hydro—electric project becomes a reality.

The western border of the Anakulam river bears rich forests that spread northwards, while the eastern border extends up to Mankulam. Herds of elephants regularly visit, drink and revel in the waters of the Anakulam river at one spot, where bubbles are always emerging from the river bed. This part of the river is directly opposite to human habitation, and is easily fordable. But the elephants never cross the river to enter cultivated land.

During daytime the local people bathe and wash their clothes at the same spot. At the close of the day, when the residents retreat, the same spot is taken over by the behemoths, who in turn return to the dense forest by day–break. The settlers are also very particular not to disturb the elephants during their revelry. They have been witnessing this for the last two to three decades.

One comes across numerous articles about elephants destroying crops and killing people. But in this area such a case is unheard of. During my visit to this area a few months back, from 2100 to 0500 hrs I observed twenty elephants, including young ones, visiting this area. Such harmonious coexistence between man and wild elephants is an unusual phenomenon.

January 13, 1989. SHAJU THOMAS

## 9. MUSK DEER *MOSCHUS CHRYSOGASTER: MUSK EXTRACTION FROM LIVE DEER*

*(With a plate and a text-figure)*

### INTRODUCTION

The Himalayan Musk Deer *Moschus chrysogaster*, a primitive ruminant, is commonly found in the Himalayan region between 2400-4300 m in Nepal. The main threat to Musk Deer survival is habitat destruction and poaching to procure musk pod from the males. But theuse of traps and snares also kills females and young indiscriminately (Blower 1974).

The musk sac is located between the reproductive organs and the umbilicus. It opens to the exterior through an orifice which lies anterior to that of the urethra. Traditionally, the musk pod is incised out ater killing the deer. The musk can also be extracted by a simple operation, but this method is time consuming and causes much stress in the deer (Shrestha 1983).

### METHODS

An 18–month old male was physically restrained and secured by three persons and placed on its side to expose the umbilical region. A silver scoop ith one large and one small groove at each end was sterilised and ubricated with antibiotic cream. Holding the musk sac with left hand, the scoop was inserted gently with a rotating movement. The edge of the scoop is smooth and rounded to facilitate easy insertion and to prevent injury to the musk gland. T musk was collected by rotating the scoop and was scooped out. Antibiotic cream was applied in the gland to prevent possible infection.The whole operation was completed within 15 miutes. Because this technique was found most suitable, scooping was repeated 6 times on the same animal.

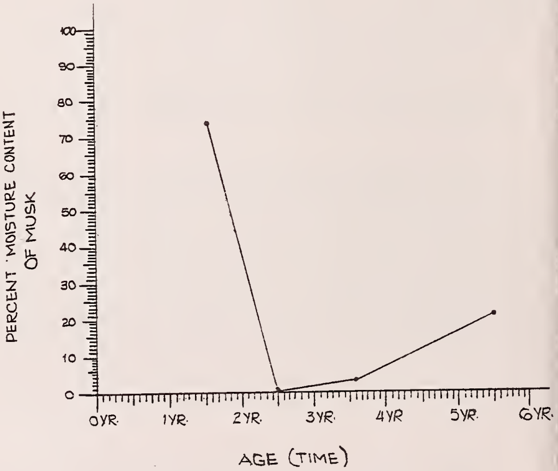
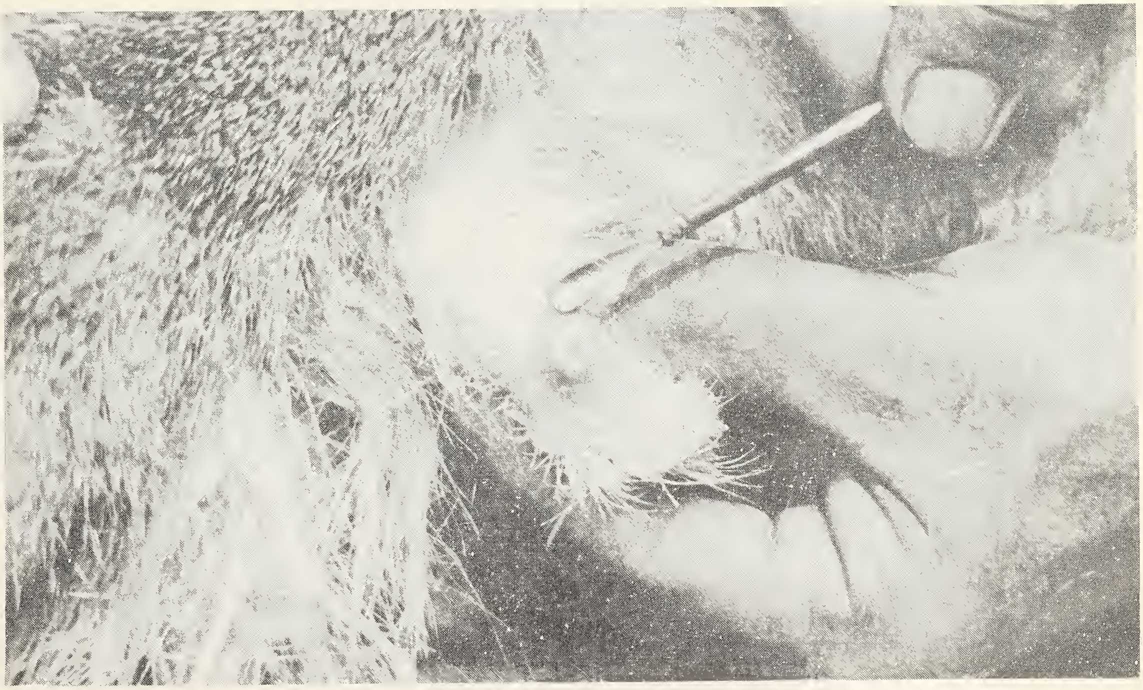


**Fig. 1.** % moisture content of musk yield at different ages.



*Above*: Musk Deer
*Below*: Extraction from musk gland, using a scoop.

TABLE 1
EXTRACTION OF MUSK AND ITS CHARACTERISTICS

| Date of musk extraction and age of Musk Deer | Musk yield in grams Wet | Dry | Moisture content in % | Colour, consistency, scent | Remarks |
|---|---|---|---|---|---|
| 1. 29 Dec 1981<br>1 year 6 months | 2.000 | 0.325 | 83.75 | Dark red brown, pasty, urine smell | Extracted at beginning of expected mating season (December – January). |
| 2. 23 Dec 1982<br>2 years 6 months | 5.700 | 5.655 | 0.78 | Dark red brown, granular, strongly scented | -do- |
| 3. 19 Jan 1984<br>3 years 7 months | 2.200 | 1.150 | 2.27 | -do- | Extracted 26 days after previous extraction. |
| 4. 6 Dec 1984<br>4 years 5 months | – | – | – | Light brown, pasty, slightly scented | Small amount extracted to check colour and consistency 3 weeks before first extraction. |
| 5. 11 April 1985<br>4 years 9 months | – | – | – | Creamy white, pasty, no remarkable scent | Small amount extracted to check colour and consistency 5 months after expected mating season. |
| 6. 21 Dec 1985<br>5 years 6 months | 3.000 | 2.380 | 20.66 | Dark red brown, granular, strongly scented | Extracted in expected mating season. |
| 7. 27 June 1987<br>7 years | – | – | – | Creamy white, pasty, no remarkable scent | Small amout extracted to check colour consistency and scent 6 months after mating season. |

## RESULTS

The length of the musk sac was 4.1 cm externally. Width and depth were 3.3 and 4.6 cm respectively. At the age of 1.5 years, the extracted musk was not of the desired quality, with a pasty appearance and pungent urine smell (Table 1). Musk at the age of 2.5 years was of good quality. The brown granular powder was strongly scented, and the yield satisfactory. At 3.6 years the musk extracted 26 days after the previous extraction was comparatively less in yield (Table 1). At 4.4 years, 3 weeks prior to be expected rut season, the musk was light brown, pasty and slightly scented. At 4.8 years musk was extracted 4 months after the expected rut season. The musk was creamy white, pasty in appearance and without scent. At 5.5 years, the musk extracted in the rut season was dark red brown, granular and strongly scented. The reduction in the musk yield this time could be due to removal of some musk earlier. At the age of 7 years, a little musk was taken 6 months after the expected mating season. The musk was immature i.e., creamy white in colour, pasty in appearance and without any scent. A sharp decline of percentage moisture content of musk yield was observed with age (Fig. 1).

## DISCUSSION AND RECOMMENDATIONS

Musk yields varied because of the diseased condition of the deer and frequent extractions of musk in small quantities to check the colour, consistency and scent of musk before and after the mating season. The quality of the musk was better when the musk was extracted between 3rd week of December and January. Musk extracted in the months of November, April and June was immature.

The musk can also be extracted annually during the rutting season by this method from adult males in the wild after capturing them with nets through a drive and releasing them after harvesting the musk. If an arrangement could be made at village level through local panchayats on an annual basis for the benefit of a specific village community, such a programme would generate a self—supporting economy, which means concrete support for wildlife conservation at grassroots level. In addition to this, the villagers would themselves become watchdogs against poaching, ensuring the survival of the endangered Musk Deer in Nepal.

December 12, 1988. MUKTI N. SHRESTHA

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## 10. SIGHT RECORD OF REDNECKED GREBE *PODICEPS GRISEIGENA* NEAR RAJKOT, GUJARAT

On 11 December 1986 at the Nyari reservoir, southwest of Rajkot city (22° 18' N, 70° 47' E), Gujarat, we observed two grebes diving under the water close to an islet on which both species of migrant cranes, Demoiselle Crane *Anthropoides virgo*, and Common Crane *Grus grus* were roosting.

The grebes were intermediate in size to our two common grebes, the Little Grebe *Podiceps ruficollis* and the Great Crested Grebe *P. cristatus*. Both these species occur regularly at this reservoir. These new arrivals were in their winter plumage and had a distinctly visible yellow base to the lower mandible, best illustrated by Peterson *et al.* (1983). This confirmed their identity to be the Rednecked Grebe *P. griseigena*. The same evening, we visited the reservoir with Prof. R.M. Naik and saw the birds again. This time they were further away and were resting in the water. On later visits that winter the birds were not observed.

So far there have been only two records of the bird from the Indian subcontinent, on the basis of which Ali and Ripley (1983) consider the bird to be a rare winter visitor. These records are from Pakistan and were made by Holmes *et.al* (1967) of one bird in winter plumage, on 14 January 1967, and by Savage (1968), of two birds, of which one was in complete summer plumage, on 24 September 1967. There is no mention of this species fromGujarat, either in Ali (1954) or Dharmakumarsinhji (1955) and so it is believed to be an addition to the list of birds for the state.

TAEJ MUNDKUR
November 17, 1987. RISHAD PRAVEZ

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## 11. MONTHLY VARIATIONS IN DIET OF CATTLE EGRET *BUBULCUS IBIS COROMANDUS* IN AND AROUND CHANDIGARH

Documentation on the feeding ecology of the Asiatic subspecies of the Cattle Egret *Bubulcus ibis coromandus* (Boddaert) is meagre. Ikeda (1956), Kosugi (1960), Mukherjee (1971), and McKilligan (1984) studied the food habits of this subspecies. Except for Mukherjee (1971), all other workers made observations only during the breeding season. Accordingly, a study was conducted from February 1984 to February 1986 to gather comprehensive information on its feeding ecology. Some results of the investigations have been reported elsewhere (Sodhi and

Khera 1984, Singh *et al. in press* Sodhi). The present paper examines variations in the diet of the Cattle Egret during different times of the year.

### MATERIAL AND METHODS

45 Cattle Egrets were shot from Chandigarh (30° 42'N, 76° 54'E) and surrounding areas between March 1984 and March 1985, each after at least one hour of feeding, so as to obtain maximum information. No egrets were shot during June, August, September or November. The stomach contents were preserved in different percentages of formaldehyde, depending on their nature. Contents of each stomach were categorized into different prey groups, namely Annelida, Odonata, etc., and counted.

To study the dominance of a particular prey group during different months, Simpson's dominance index $\lambda = S\ \Sigma\ P_i$ was calculated, following Ruiz (1985). $P_i$ is the number of prey in one stomach divided by the total number of prey encountered in the same stomach. Simpson's dominance index is a measure of the expected frequency of particular prey and offers an estimate of dominance of a given prey group in the predator's diet (Ruiz 1985). Values less than 0.01 in preliminary calculations were discarded.

To estimate diversity in the diet, mean number of food items and mean number of food objects were calculated for different months. Food item, as referred here, is a particular food group, e.g. Annelida, Odonata, etc., and food object is the total of all food items. Further, foraging index = mean number of food items/mean number of food objects x 100 was calculated for each month to get an idea of the quantities of food objects in terms of variety of food items, following Siegfried (1972).

### RESULTS

Table 1 presents Simpson's dominance index for each prey group during different months. From the table it is evident that Coleoptera (January), Diptera (February to April), Lepidoptera (May and December), and Orthoptera (July and October) were the most important prey groups. Based on dominance index, Diptera, Orthoptera, and Coleoptera were the three most important prey groups (Table 2). Table 3 infers that Cattle Egrets consumed most diverse food in February and least diverse food in December.

### DISCUSSION

From the analysis, it is evident that the Cattle Egret is predominantly an insect forager. It is morphologically adapted to feed on insects (Dubale and Mansuri 1969, 1972, Payne and Risley 1976).

The variations in their diet during different months may be due to: (a) availability of a particular prey group in nature during those months, (b) their ability to catch that particular prey, or (c) prey selection being influenced by

TABLE 1

SIMPSON'S DOMINANCE INDEX OF DIFFERENT PREY GROUPS IN DIFFERENT MONTHS

| Prey group | Jan. | Feb. | Mar. | Apr. | May | Jul. | Oct | Dec. |
|---|---|---|---|---|---|---|---|---|
| Annelida | - | 0.01 | - | - | + | 0.32 | - | - |
| Odonata | 0.17 | + | 0.04 | - | 0.05 | - | 0.01 | - |
| Orthoptera | 3.34 | 2.43 | 2.68 | 0.22 | 0.09 | 5.29 | 1.36 | 1.18 |
| Dermaptera | + | + | 0.06 | 0.01 | - | - | 0.45 | - |
| Dictyoptera | + | + | + | - | - | + | - | - |
| Hemiptera | - | + | + | - | 0.06 | - | - | - |
| Coleoptera | 4.75 | 0.67 | 0.65 | 0.04 | + | 1.96 | + | + |
| Diptera | 1.02 | 7.18 20.97 | 2.49 | 0.04 | 1.61 | + | 0.01 | |
| Lepidoptera | 0.75 | 1.58 | 1.76 | 1.82 | 1.51 | 0.03 | + | 2.04 |
| Hymenoptera | + | 0.02 | 0.05 | - | - | 0.09 | - | - |
| Arachnida | 0.28 | 0.09 | 2.68 | 0.02 | + | 0.27 | 0.02 0.03 | |
| Chilopoda | - | + | - | - | - | - | + | - |
| Amphibia | - | - | - | - | - | 0.07 | - | - |
| Reptilia | - | - | - | - | - | + | - | - |
| Mammalia | - | - | - | - | - | - | - | + |
| Sample size | 7 | 7 | 11 | 4 | 3 | 7 | 2 | 3 |

+ = Values less than 0.01.

TABLE 2
SIMPSON'S DOMINANCE INDEX OF DIFFERENT PREY GROUPS. 11 IS PERCENTAGE OF DOMINANCE INDEX VALUES

| Prey group | l | $l_1$ |
|---|---|---|
| Annelida | 0.57 | 0.19 |
| Odonata | 1.06 | 0.36 |
| Orthoptera | 107.53 | 36.63 |
| Dermaptera | 0.77 | 0.26 |
| Dictyoptera | + | - |
| Hemiptera | 0.09 | 0.03 |
| Coleoptera | 29.92 | 10.19 |
| Diptera | 132.02 | 44.97 |
| Lepidoptera | 7.68 | 2.61 |
| Hymenoptera | 0.77 | 0.26 |
| Arachnida | 13.03 | 4.43 |
| Chilopoda | + | - |
| Amphibia | 0.07 | 0.02 |
| Reptilia | + | + |
| Mammalia | + | + |

+ = Values less than 0.01

TABLE 3
MEAN NUMBER OF FOOD ITEMS CONSUMED AND FORAGING INDEX DURING DIFFERENT MONTHS

| Month | Mean no. of food items | Foraging index |
|---|---|---|
| Jan. | 4.14± 1.86 | 3.58 |
| Feb. | 6.85± 2.73 | 2.16 |
| Mar. | 6.18± 1.40 | 7.37 |
| Apr. | 5.25± 0.95 | 8.03 |
| May | 5.00± 0.0 | 25.50 |
| Jul. | 4.42± 1.90 | 24.40 |
| Oct. | 6.50± 0.70 | 26.00 |
| Dec. | 4.00± 1.73 | 15.00 |

some physiological stimuli (Ruiz 1985).

The most important prey group during the present study was Diptera. Earlier, Orthoptera was found to be the most important prey group in Egypt, South Africa, Sundarban (India), North America, Australia, while Coleoptera and Amphibia were the most important in Japan and Spain (Kadry-Bey 1942, Siegfried 1966, Mukherjee 1971, Jenni 1973, McKilligan 1984, Ikeda 1956, Ruiz 1985). The dominance of a particular prey group in diet, in a region, is perhaps due to abundance of that prey group in that region (Sodhi 1985).

## ACKNOWLEDGEMENTS

I am grateful to the ICAR, New Delhi, for financing this research. Thanks are due to Dr Navdeep Singh, Prof. S. Khera and Mr Rajiv Singh for their help, and to Dr Lynn W. Oliphant for making comments on this manuscript.

March 16, 1988. NAVJOT S. SODHI

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## 12. BROWN BOOBY *SULA LEUCOGASTER* (BODDAERT) ON THE WESTERN COAST

(*With a text-figure)*

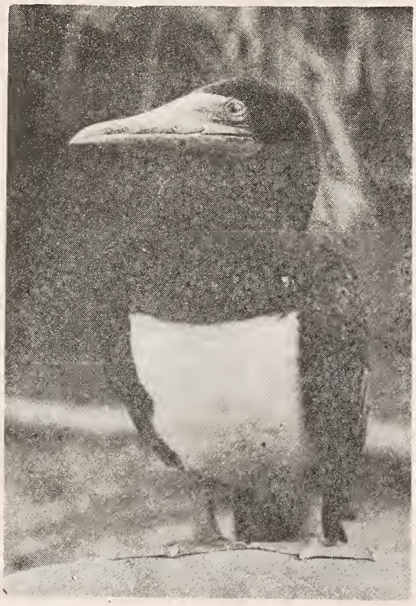

Fig. 1. Brown Booby *Sula leucogaster.*

While birdwatching at Mandvi in Kutch, Gujarat, on 22 August 1987, some distance short of the mouth of River Rukmavati which joins the Arabian Sea, opposite the town and port of Mandvi, a fisherman told us that he had seen a sea bird which he said he had not come across before. When we went to the spot pointed out by him we saw a Brown Booby Sula leuco–gaster, sitting quietly. We approached it very close and even when we caught it, it showed no signs of fright. We therefore felt it was either injured (there was no external sign of injury) or ill. We then had the bird photographed. On studying the literature it appears that except for a specimen collected from the Malabar coast, this is the only record for the western sea board. M.K. Himmatsinhji, to whom we showed the photo and who has confirmed our identification of the Brown Booby, thinks it is an accidental occurrence, and that we should try to collect it as specimen for the Society.

S.N. VARU
September 22, 1987. N.N. BAPAT

## 13. OCCURRENCE OF *CICONIA CICONIA* GRUIDAE AND BREEDING OF PHOENICOPTERIDAE IN KUTCH, GUJARAT

Apparently the White Stork was first recorded in Kutch, Gujarat, by Capt. C.D. Lester during the last century; he saw a pair of them at Devisar tank (about 14 Km. north of Bhuj) in August 1895. The Salim Ali survey in 1943–44, prior to the publication of 'The Birds of Kutch', did not come across it. However, I am not aware whether he himself or anyone else recorded *Ciconia ciconia* in Kutch in subsequent years. I saw one in the Banni in December 1954. Since then I have come across them in ones and twos on several occasions, but during the last decade or more an ever increasing number of these storks have been seen. The number of *C. ciconia* mentioned by A.A. Vaidya in his note in *J. Bombay nat. Hist. Soc. 83*(2): 433, appears to me rather highly exaggerated. It is likely he counted some birds in flight which also included flying Pelicans *Pelicanus onocrotalus* which it is possible were mistaken for White Stork. The 'famous dhandh' mentioned by Vaidya (the word 'dhandh' in Sindhi and Kutchhi means a shallow collection of water) is known as the 'dhandh' of Chhari, a village nearby, where the Greylag Geese used to come in large numbers in the years gone by. They no longer visit Kutch now. This lagoon is situated almost where 'mainland Kutch' ends and a part of the western Banni begins, about 30 Km. or so from where the Great Rann of Kutch is situated. I call this wetland 'mini Nal Sarovar'. I have come across this bird over the years as hereunder:

I counted 40 in the marshes on both sides of the Bhuj–Pachham road in the Banni in 1979. On 10 February 1980 I saw 100+ White Storks in the marshes interspersing and surrounding a large collection of water about 4 Km.

west—northwest of Bhirandiara village in the Banni. The extent of water and marsh was so great that it was not possible to approach the area from all sides, and so a full and proper count could not be undertaken. These storks were dotted about all over in big and small groups and also singly as far as the eye could reach, and perhaps there were many more of them beyond, which were not visible. The Blacktailed Godwits were there too, in such vast numbers that they defied an exact count.

During the 1978 rainy season pesticides were sprayed on the hill feature known as 'Kala Dungar', overlooking the Great Rann of Kutch, to destroy a swarm of the Desert Locust which had settled there. Soon after this a heavy shower of rain fell on the hill which washed down the poisonous substances into the Rann, destroying all forms of aquatic life. The flamingo did not breed either that year or in subsequent years. In fact they abandoned the famous 'flamingo city'. However, in recent years some juveniles have been regularly sighted which belonged both to *Phoenicopterus roseus* and *Phoeniconaias minor*. In this context the 'Habhi Flamingos' mentioned by A.A. Vaidya in *J. Bombay nat. Hist. Soc. 83*(3): 661 were surely juveniles, as very rightly remarked by the late Dr Salim Ali at the foot of the note concerned. I may mention here that the Kutchhi name for the flamingo is 'hunj', and that the term 'Habshi Flamingo' (literally meaning 'negroid flamingo') was coined by a person from the island of Khadir a few years ago when he saw some juvenies for the first time and thought they belonged to a different race of this bird! Similarly the Banni is an alluvial grassland which at present is ruined in parts by overgrazing. *Prosopis juliflora* has grown and spread unchecked over large parts of it, thus reducing the area available to the Great Indian Bustard for breeding there during the monsoon months. The local people of Kutch have divided the Banni into the eastern and western parts in common parlance; and there is no part of it that is locally known as 'Nani—Banni'.

Coming back to sightings of juvenile flamingo, I saw 3 on 10 September 1978, a large number of them along with juvenile Rosy Pelicans on 21 September 1980, in the Banni, 30 adults with a few juvenile *P. roseus* at Laeja Creek, Mandvi, on 10 October 1982. The largest number of juveniles seen by me were those of the Lesser Flamingo on 7 January 1984 in the western part of the Great Rann. There were about 600+ young — half of these appeared to be larger from an earlier brood, while the rest were smaller and darker coloured, seeming to have come from a colony nearby. These were accompanied by 100+ adults; the total number of Lesser Flamingo present at that collection of water was approximately 800. Apart from this I saw 1 juvenile Lesser Flamingo with an adult on the Laeja creek on 12 January 1986. From this it would seem that the flamingo have started to breed in the Great Rann, and perhaps in and near the Little Rann as well in small colonies. During the last three years there was paucity of rain, and this year is a complete famine; so there is no question of any breeding taking place. However, in a normal year in future, when the Great Rann gets flooded again, proper investigations need to be carried out to find out where these birds breed. *Phoeniconaias minor* breeds mostly in saline water, and so there is every likelihood of finding their nesting colonies, big or small, in the tidal creeks both to the east and west of the Great Rann of Kutch, or even in the Little Rann itself.

Without meaning to contradict Vaidya's reference to *Anthropoides virgo* seen by him in Kutch and also to record my own observations on cranes in Kutch, it is more likely he saw *Grus grus*, which is always to be seen in the Banni. The former is hardly seen in this part of Kutch; and even normally, far fewer numbers of them than *G. grus* visit us here. I have seen *A. virgo* only once in the Banni, on 7 October 1967. I have never come across a congregation of the Common Crane exceeding 1000 birds at a time at one location in Kutch. Besides, to the east, northeast, north and northwest of the Dhandh of Chhari lies the vast Banni, in which no cultivation is practiced; and to the southeast, south and southwest there are hilly tracts where the crops of either groundnuts or foodgrains are not sufficient to support such a vast concourse of cranes, particularly at the time of year Vaidya saw them. About the count of cranes undertaken by the Gujarat Forest Department, I may point out here, as I did to Vaidya soon after the count was taken in Kutch, that this was done in the month of February when the return migration of the birds starts; and at that time many cranes pass through on their way to their breeding grounds up north. Obviously, therefore, this kind of census could not present the true picture of cranes present in Kutch. The birds first arrive in their winter quarters from about September onwards, and so the best time to take the count would be any time between November and January.

During scarcity or famine years hardly any cranes remain in Kutch during the cold weather. This year we are in the grip of the worst famine in living memory, and there are neither any crops or water in most of the tanks and irrigation dams. Similar conditions prevail in many parts of north Gujarat and some areas in Saurashtra, and so the cranes along with ducks and other waterbirds would all go further south. I heard the calls of Common Cranes in September, but have not seen any birds so far.

October 29, 1987. M.K. HIMMATSINHJI

## 14. REAPPEARANCE OF *ANSER INDICUS* (LATHAM) AND *TADORNA TADORNA* (LINNAEUS) IN KUTCH, GUJARAT

One of the authors of this note (NNB) saw three Barheaded Geese on 6 November 1987 at the Rudramata Dam, about 14 Km. north of Bhuj, Gujarat. When both of us went there the next day and on the 8th along with the other members of the Pelican Nature Club of Kutch, the geese were still there. *Anser indicus* has always been a very rare cold weather visitor to Kutch, Saurashtra and the other parts of Gujarat. Even in earlier years, when *Anser anser* used to come regularly (they stopped coming over fifty years ago), the barhead hardly ever came this way (Vijayarajji, *J. Bombay nat. Hist. Soc 21:* 678). So it is perhaps after over half a century that this goose has been seen here.

After three years of scarcity of rain, this season we have had a total failure of the monsoon rain. Consequently, except for two or three irrigation dams which have some water in them, all the other lakes, reservoirs and village tanks are empty, or in the process of drying up. In the Rudramata Dam itself the level of water is quite low. As it recedes, part of the dam bed is ploughed, and Sorghum *Panicum* sp. sown, which is at various stages of growth in the wet silt that tends to remain moist for quite some time. The geese do not fly anywhere to feed, as they usually do, but just waddle over to any one of the cultivated plots of their choice and start feeding!

On November 13th, NNB saw one Common Shelduck at the dam. This duck is also rare in this part of the country. The first record of its occurrence in Kutch was that of one Col. C.B. Obrien in 1921. The second was by Maharao Madansinhji, who saw two of these ducks in a small pool of water in the coastal sand dunes about 10 Rm. west of Mandvi on 4 December 1966. He collected one specimen (sex not known). Thus the recent sighting of *Tadorna tadorna* comes after an interval of 21 years.

As with Kutch, neighbouring areas of Sind (Pakistan) to the north and some districts of Rajasthan to the northeast are also experiencing drought conditions , as a result of which these waterfowl seem to have strayed into Kutch. The Common Shelduck, according to the 'HANDBOOK' (Ali & Ripley), is known to visit parts of Sind regularly during recent years.

M.K. HIMMATSINHJI
N.N. BAPAT

December 8, 1987.

## 15. PARIAH KITE *MILVUS MIGRANS* CAPTURING WHITEBREASTED KINGFISHER *HALCYON SMYRNENSIS*

A commotion was created when a Pariah Kite *Milvus migrans* captured a Whitebreasted Kingfisher *Halcyon smyrnensis* in the JIPMER (Jawaharlal Institute of Postgraduate Medical Education and Research) campus in Pondicherry one June afternoon.

A number of Pariah Kites have taken up residence on top of the three storey JIPMER building and adjoining places, possibly attracted by the Central Animal House nearby, where laboratory animals are being bred. On this particular afternoon four kites were seen flying about frantically, with a dozen or so noisy house crows in hot pursuit. One of the kites flying overhead at a low level had a Whitebreasted Kingfisher firmly in its talons. The kingfisher's cries of agony were clearly audible. The commotion died down after about 2 minutes, when the kite managed to escape with its prey.

The kite had to face two problems after grabbing the kingfisher: avoiding the crows excited by this act of capture by the kite, and preventing the other kites from forcibly taking possession of the kingfisher.

It is not known when, where and how the kite caught the kingfisher. Whitebreasted Kingfishers are very commonly seen in this locality. Pariah Kites are known to lift poultry, and have also been reported to capture bats (Ali & Ripley 1983).

June 26, 1987.

E. NARAYANAN

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## 16. SIGHTINGS OF GOSHAWK *ACCIPITER GENTILIS* IN HINGOLGADH, GUJARAT

The Goshawk *Accipiter gentilis* is a rare winter visitor to north India (Ali and Ripley 1983), though it has been recorded as far south as Poona in Maharashtra (Ingalhalikar *et al.* 1987). In Gujarat, there are only two earlier records of the bird from Gir forest and Bhavnagar (Dharmakumarsinhji 1955).

For two consecutive winters now, a single bird was observed at the Hingolgadh forest (Hingolgadh Nature Educational Sanctuary). This forest is located 17 Km east of the town of Jasdan. It is a small scrub forest, one of the few forested areas now left in Saurashtra, and thus serves as an important stopover point for a variety of migrant passerine species, though it has come under increasing human and cattle pressure in the last three years.

We saw a bird on 17 September 1985, and identified it as a female Goshawk from its size and colour. She was seen diving on flocks of Rosy Pastor *Sturnus roseus*. The Rosy Pastors had just arrived; a majority of them were juveniles, and foraging for the ripe berries of *Rhus mysurensis*. A year later, on 5 October 1986, we again saw a single female Goshawk in the same locality, engaged in the same activity as in the previous year. In September—October of 1987 we kept a look—out for the Goshawk, but the bird did not turn up. There was no mass flowering and fruiting of most of the trees and bushes due to insufficient rains during the preceding monsoon and there were very few Rosy Pastors in the forest.

It is documented for a number of avian raptor species that during southward migration of passerines and other birds, the raptors follow and prey off them. For example, in northern Asia migratory Shaheen Falcon (Barbary Falcon) *Falco peregrinus babylonicus* follow Pintail Sandgrouse *Pterocles alchata* and Pallas's Sandgrouse *Syrrhaptes paradoxus* (Dementiev 1957), while the Merlin *Falco columbaricus* is believed to follow some passerines during both autumn and spring migrations (Cade 1982). From our observations it appears that the Goshawk follows and preys on Rosy Pastor during autumn migration.

**PS:** A pair of Goshawks were observed in the same area on 16 October 1988 in the company of Kestrels *Falco tinnunculus*.

SHIVRAJKUMAR KHACHAR
November 12, 1987. TAEJ MUNDKUR

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## 17. FOOD STORAGE BY BONELLI'S HAWK–EAGLE *HIERAAETUS FASCIATUS*

A pair of Bonelli's Hawk—Eagles nest on a Dalbergia tree on a hill slope at Pashan near Pune, Maharashtra. The same nest has been in use for the last four years. During the last season i.e. late in the winter of 1986—87, two chicks were successfully reared. We observed and recorded the nesting activities during this season.

Two eggs were laid by the female in the third week of December. One hatched on 19 January 1987 and the other one on the following day. We witnessed the hatching of the second egg, which took place at 0845 hrs. The female was present on the nest from dawn, covering the day old chick and the second egg. She looked restless from about 0830 and repeatedly passed her bill under her chest where she had placed the egg. At 0845 hrs she suddenly took off with the eggshell in her bill. Perching on a tree about 300 m away she dropped the eggshell, preened for five minutes and returned to the nest.

After about 15 minutes, were surprised to see her feeding the chicks. At first we thought that she was picking up the leftovers from the previous day's meals, but soon we realised that it was an entire kill untouched so far. It had been inside the nest (we hadn't noticed it until then) and we guessed it was a bird the size of a dove. The bird could not be identified at that time. It was obvious, however that it was killed on the previous day since the female did not leave the nest (except to throw away the eggshell) that morning and the male did not turn up.

We found that up to a period of four weeks after the chicks were born, food was regularly stored, which served as breakfast for the chicks. Prey could be identified several times and consisted of more than 90% birds (mainly mynas, Blue Rock Pigeons, quails, doves and domestic pigeons), occasionally small mammals (species could not be identified) and rarely lizards.

During the first 11 days the male hunted alone and brought food for the female and the chicks. After 12 days both parents started hunting together, leaving the chicks in the nest. In either case hunting started only after 0930 or 1000 hrs. In the chill January mornings, apparently thermals were not available till 0930 hrs. The chicks, however, had their breakfast every morning before 0900 hrs. This was only possible due to stored food. We also watched the eagles in the evening and saw that the last kill of the day was neither eaten nor fed to the chicks.

After the fifth week food was not stored regularly. Both chicks, with their growing appetites, finished practically everything of the day's kills and hardly anything remained to be stored.

The food storage was thus deliberate, consistent and followed a specific pattern. This habit may have served the following purposes.

1. Tenderizing meat: the storage time ranged from 12 to 20 hours, probably sufficient for softening of meat but not enough for development of maggots. We also noted that during the first three weeks the harder and rougher portions like large bones and legs wre eaten by the female and tender part fed to the chicks.

2. Eagles are known for their ability to stand prolonged starvation as adults. However, young eagles below four weeks naturally do not have this ability, and they need food early in the morning. Since thermals were not available during this time of the year, hunting was not possible in the early hours, and storing food was obligatory. Later in March, when the chicks were more than five weeks old, and as the weather grew warmer, early hunting was possible. The earliest successful kill was noted at 0835 hrs on 22nd March.

We therefore think that storage of food is an indispensable part of the nesting activities and is vital for the survival of chicks during their younger days.

MILIND WATVE
VIJAY JOSHI
NIRANJAN SANT
SUNIL RANADE

July 2, 1987.

## 18. AVOCET *RECURVIROSTRA AVOCETTA* IN KERALA

On 28 November 1986 at the Kadalundy Estuary, about 20 Km. south of Calicut town, Kerala, where the Kadalundy river discharges into the sea, extensive mud—flats are exposed during low tide. From September 1985, we have been making regular weekly observations at the estuary. One of us (L.N.) spotted a single Avocet on the mudflats standing among the many gulls and terns. The bird was observed from 0900 to 1300 hrs.

This species is not included in Salim Ali's BIRDS OF KERALA (1969). The HANDBOOK Vol. 2 (Compact Edition, 1983, p. 178) says: "Not in Kerala, Andamans and Nicobar Islands or in the Maldives".

L. NAMASSIVAYAN
R. VENUGOPALAN

December 1, 1987.

## 19. BREEDING RECORDS OF CREAMCOLOURED COURSER *CURSORIUS CURSOR CURSOR* (LATHAM) FROM INDIA

About the breeding of the Creamcoloured Courser *Cursorius cursor cursor* (Latham) in the Indian subcontinent, Ali and Ripley (1983) write, "extralimital but some suggestive circumstantial evidence of nesting, sporadically (?) in Bahawalpur and Kutch". Recently, Sharma (1986) in mid—February, found small chicks of this species in the Diyatra region of Bikaner district. On a trip to Jaisalmer in Rajasthan, on 27 July 1987, at about 1830 hrs, we saw two chicks and two adults of the Creamcoloured Courser. The birds were seen in a barren area near Nibha village, between Sam and Sudasari *chowkis* of the Desert National Park. The chicks were able to fly a short distance. At a later date, we saw one more individual of the courser in a different area of the Park. These two recent breeding records prove that the Creamcoloured Courser is not just a winter visitor to India, as opined by Ali & Ripley (1983) but that it also breeds within our limits.

ASAD R. RAHMANI
RANJIT MANAKADAN

August 13, 1987.

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## 20. TAXONOMIC STATUS OF *PSITTACULA INTERMEDIA* (ROTHSCHILD)

While commending the authors of the recent paper 'On the taxonomic status of *Psittacula intermedia* (Rothschild)' (Sane *et al*. 1987) for undertaking an interesting study on biochemical characteristics of four species of Indian parakeets to understand their taxonomic affinities, with special reference to the little—known Rothschild's Parakeet, I cannot refrain from commenting on certain points presented in the paper.

1. The presence or absence of the wing—patch has been given too much importance in sex—distinction in *Psittacula intermedia*, especially when it may be present or absent or obsolete in one or both sexes in the allied species. Thus, the authors conclude (p. 128, para 4), solely on the basis of the absence of the wing—patch in two captive adult male specimens, "that contrary to the assumption of Biswas (1959), the 6 skins of adult *P. intermedia* in the collection of AMNH are all females", inspite of the fact that they all have plum—coloured heads! I should be interested to know about the colour of the heads of the two adult males of Sane's collection, one skinned and in BNHS collection and the other alive, and of the subadult female, also alive.
2. The authors write in the same para: "It is not clear to us as to how Biswas (loc.cit.) and others before him identified the all—green seventh skin in AMNH as an immature specimen of *intermedia* since it could as well be that of *himalayana*". Compare this with what I had written in my 1959 paper (p. 559): "... the seventh ... is an immature specimen being green all over, ... Incidentally, it may be added that this specimen has as long a wing as that of the longest—winged male specimen, and it matches well with immature examples of *P. himalayana*, both in coloration and in size. I am thus led to consider it as an immature specimen of *P. himalayana* ..."! I wish the authors had read my paper a little more carefully.
3. In Table 1 (p. 128), the wing measurement 168 given for a paratype, should be 158 (Biswas 1959, p. 561, Table 1). It is strange that the item no. 3 in the same Table is given with wing— measurement of 153/151 and the bill, 21.5, although these figures when measured in the living bird were 161 and 21 respectively.
4. It is also noted that the authors gave no importance to certain other important characters such as the colours of the crown, the under wing—coverts and the tips of central rectrices.

November 17, 1987. BISWAMOY BISWAS

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## 21. PIED CRESTED CUCKOO *CLAMATOR JACOBINUS* — THE HARBRINGER OF THE MONSOON

In the Kathiawad peninsula in Gujarat, everything revolves around the success of failure of the monsoon. The migratory Pied Crested Cuckoo is associated with the advent of the monsoon in the region.

Very few birds migrate to India from Africa. The Pied Crested Cuckoo is one of them. Coming with the monsoon winds, it crosses the Arabian Sea with the favourable southwest wind and returns to Africa with the northwest winds in October—November. On both the ocean crossings it thus takes full advantage of the prevailing favourable winds. There are not many records from the Oman and Mekran coasts, and the bird presumably flies more directly over the Arabian Sea.

I have always looked forward to the arrival of the season's first Pied Crested Cuckoo, and have invarialy first heard the bird calling at night while flying high overhead. For the last 7 years I have kept a record of these dates, which are as follows:

| | |
|---|---|
| 18 June 1981 | – First heard at Hingolgadh. |
| 5 June 1982 | – Full moonlight. Heard calling at 2300 hrs |
| 7 June 1982 | – Heard calling at 2300 hrs. |
| 8 June 1982 | – Moonlight clear night. Heard calling<br>– and flying overhead west to east<br>– monsoon over Kerala and Madras. |
| 9 June 1983 | – Heard calling and flying high overhead at 0020 hrs. |
| 2 June 1984 | – Heard calling early in the morning at 0315 hrs<br>Monsoon current over Kerala since 31 May 1984. Weak current. |
| 3 June 1984 | – Heard calling and flying high overhead at 2330 hrs. |
| 4 June 1986 | – Heard calling and flying high overhead early in the morning at 0330 hrs |
| 4 June 1987 | – Calling and flying high overhead at 2310 hrs. Monsoon over Kerala and Goa. |

Every time I have heard the call, the cuckoo was flying from west to east. This is the normal direction for it to migrate from Africa into the Indian subcontinent. I have never heard it calling and flying in any other direction in all these years.

Since some years the numbers of Pied Crested Cuckoos in the Jasdan area have decreased. The scrub forest at Hingolgadh is getting sparse. Grazing by cattle and goats and cutting of grass as well as trees and bushes for fuel have disturbed the bird life of the area. The Yellow Eyed Babbler, a former breeding resident, has not been seen for the last few years and the White Bellied Minivet is also on the way out. The *Acacia* groves have thinned out and with the loss of grass and bush cover the numbers of Common Babblers — the main hosts of the parasitic Pied Crested Cuckoo — have declined. Perhapse, the numbers of the Pied Crested Cuckoo have gone down in the Jasdan area due to these several factors.

June 16, 1987. SHIVRAJKUMAR KHACHAR

## 22. FEEDING BEHAVIOUR OF WHITEBREASTED KINGFISHER *HALCYON SMYRNENSIS* (LINNAEUS)

At 1115 hrs on 1 January 1987, I saw a Whitebreasted Kingfisher on the parapet of a nullah near my house in Udaipur, Rajasthan. The bird had a frog in its beak. It started beating the frog on the parapet, then flew to a tree in the compound of our house and started beating the frog on a branch. I tried to photograph it, but it was disturbed and flew further up into dense foliage.

It beat the frog on the branch for half an hour. At 1145 hrs it started swallowing the frog. It took 10 minutes to swallow it and in the meanwhile it excreted four times. While swallowing, it was breathing heavily and this state remained for 15 minutes. When the legs of the frog disappeared into its gullet it remained in a stiff position. Meanwhile some bird of prey flew overhead and many birds either ducked or flew away, but the kingfisher remained still.

To see the reaction of the bird I beat the trunk of the tree and made noises, but it did not move. The bird remained in this state for four minutes. Then it started moving its head, and gradually its breathing became less heavy. After 20 minutes of the swallowing of the frog the kingfisher flew away.

January 20, 1987 RAZA TEHSIN

## 23. BLACK DRONGO *DICRURUS ADSIMILIS* NESTING ON ELECTRIC POLE

The Southern Black Drongo *Dicrurus adsimilis* (Bechstein) is known to nest generally on trees (Ali & Ripley 1972, Shukkur & Joseph 1980). However, we found a pair nesting on an electric pole in the Circuit house compound, Visakhapatnam, Andhra Pradesh, even though there were a number of large sized suitable trees nearby.

The nest was located in a small space between the horizontal and vertical sections of the cemented pole, just below the lower power line. It was first observed on 21 July 1987 with an adult bird brooding in the nest. On 24th July we noted two fledglings. We photographed the nest and a fledgling on 29th July. They remained in the nest till about 29th August. On 27th and 28th August, we noted only one parent feeding the young till as late as 1905 hrs (sunset that day was at 1827 hrs) by bringing flying insects attracted to the nearby light.

We cannot understand whether this rather unusual nest site provides any special advantage to the bird, especially when there are suitable trees nearby. Could it be that the bird selected the location to take advantage of abundant insects that were being attracted to the lights, so that it could feed its young with relatively less effort?

K.S.R. KRISHNA RAJU
December 17, 1987. U.V. BAIRAGI RAJU

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## 24. COMMON MYNA AS A CAMPFOLLOWER OF LESSER WHISTLING TEALS

The Common Myna is known to follow domestic cattle, horses and wild herbivora when they graze. The grazing animals disturb insects which become easily accessible to the mynas.

One afternoon I saw a flock of 9 Lesser Whistling Teals land on the banks of the Mula—Mutha bird sanctuary and waddle into the grassy bank looking for food. A few minutes later they were joined by a few Common Mynas. Soon about 20 of them aggregated around the teals and followed them persistently down thebank for about 50 m. The next day the teals arrived at the same time, and were immediately spotted by the mynas, who seemed to appear from nowhere began following them much more closely. In fact they seemed to pick up insects from just around the feet of the teals. I saw the same pattern repeated again three times during the next couple of days.

This shows how rapidly such a bond between different species can be formed when food availability is a motivating factor.

June 6, 1987. E.K. BHARUCHA

## 25. TOOL– USING BEHAVIOUR IN INDIAN HOUSE CROW *CORVUS SPLENDENS*

Tool–using behaviour in birds and other animals has been described by many authors. The Woodpecker–finch *Cactospiza pallida* and the Mangrove–finch *c. heliobates* of the Galapagos islands use Cactus spines, leaf petioles, twigs, etc., for probing into holes and crevices during their food search. Recently Orenstein (1972) recorded tool–use in the New Caledonian Crow, *Corvus moneduloides*.

On 8 January 1987, we had an opportunity to observe activity related to tool–use in the Indian House Crow *Corvus splendens*. At 1248 hrs we saw a House Crow on a *Manilkara hexandra* tree, just 2 m below the canopy (the total tree height is *c.* 7 m) busily engaged in an intricate behaviour. We were sitting about 10 m away from the tree. The crow perched on a small branch, plucked a leaf and immediately thrust it into a hole in one of the big branches just opposite its perch. After thrusting in the leaf it waited for about a minute, removed the leaf the hole and, holding it under its feet, pecked at some prey from the leaf and ate. It then dropped the leaf, plucked another leaf, thrust it into the hole and repeated the operation. The bird repeated this process dexterously till 1302 hrs. We recorded it performing this activity five times. Twice it dropped the leaf without picking up anything; apparently there was no prey attached to the leaf. During these observations we also noticed the crow thrusting its beak alone deep into the hole twice but without success.

When the crow left the perch, one of us immediately climbed the tree and investigated the hole to determine the food that the crow had obtained. We found a colony of ants,*Sima* sp. deep inside the hole. The depth of the hole was 12 cm. We collected nine *Manilkara hexandra* leaves from under that branch on the ground where the crow had sat. We had observed the crow using the leaf as a tool five times but the number of dropped leaves collected on the ground indicates that the process was on well before we located the crow. This repeated use of leaves by the crow to obtain prey is of a clear—cut evidence of tool—use by the crow *Corvus splendens*.

S. ALAGAR RAJAN
June 17, 1987. P. BALASUBRAMANIAN

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## 26. RANGE EXTENSION OF YELLOWBELLIED WREN–WARBLER *PRINIA FLAVIVENTRIS*

According to Ali & Ripley (1983), two races of the Yellow bellied Wren–Warbler occur in India. *Prinia flaviventris sindiana* is present in Punjab and Pakistan, in the plains of the Indus river system, and south through Sind. Its habitat has been given as riverine tamarisk, sarkhan grass jungle or reed beds. The other subspecies, *P.t. flaviventris*, occurs from Bengal eastwards through Assam, Manipur and Nagaland in habitats of humid grassland with bushes, elephant grass and reeds. There is a single post–Hodgsonian record from Rapti Dun in Nepal. However, Fleming *et al* (1976) mention it as resident and occasional in Nepal. There is a single specimen from Meerut of uncertain subspecification in the Society's collection (Abdulali 1986). The ranges of both subspecies are disjunct and thus the species appears to be absent from the Uttar Pradesh *terai*.

In May 1987, on a visit to Dudhwa National Park, Lakhimpur- Kheri district, Uttar Pradesh to study the Bengal Florican I saw the Yellowbellied Wren–warbler quite frequently. One pair that I was able to watch for a while was seen building a nest. A few days later, the repeated clamouring of the young and the frequent visits of the parent birds with food to the nesting site announced a successful hatching. While the lemon yellow lower belly is a character that makes this Wren–warbler unmistakable, photographs were also taken to confirm the identification. Though the subspecies of the Yellowbellied Wren–warbler seen at Dudhwa is uncertain, it is undoubtedly an extension of the range of the species in India. However, as it is present in the Nepal *terai* (Fleming *et al* 1976, Inskipp & Inskipp 1985) the occurrence of the Yellowbellied Wren–warbler in the Indian side of the *terai* should have been expected.

October 8, 1987. RAVI SANKARAN

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## 27. ON SOME WILLOW WARBLERS (*PHYLLOSCOPI*) IN THE COLLECTION OF ST. XAVIER'S HIGH SCHOOL, BOMBAY

While cataloguing the *Phylloscopi* in the BNHS Collection with Mr Humayun Abdulali, those at St. Xavier's High school, Bombay, Maharashtra, mostly collected by Br. A. Navarro S.J. were also examined. There is nothing of startling interest, but several of them add a little to the known distribution of some species and may be worth recording. The first number corresponds to that in Ripley's SYNOPSIS (2nd edition 1982).

1575 *Phylloscopus collybita tristis* (Blyth): The earlier Maharashtrian records supported by specimens in the Bombay collection are 3 from Madhmeshwar, Nasik district. The present specimens include 3 from Nasik collected on 28 December 1967, 24 January 1966 and 27 January 1973 and one from Poona on 4 September 1966. There are no records from the Konkan below the Ghats though the birds have been noted further south from North Kanara.

1591 *Phylloscopus inornatus mandellii* (Brooks): Coll. No. 1675 from Barlowgunj, Mussoorie, obtained on 22 October 1963 was marked *Seicercus xanthoschistos albosuperciliaris* We make it *Phylloscopus inornatus mandellii* and this appears to extend the distribution about 10° west of Sikkim.

1592 *Phylloscopus inornatus inornatus* (Blyth): Male Coll. No. 1887 obtained at West Khandesh on 30th December 1961 is an addition to the list of birds recorded from Maharashtra.

1601 *Phylloscopus magnirostris* from Kotagiri, Nilgiris. Attention is drawn to this record because the species has not been very often noted in the south.

1602 *Phylloscopus trochiloides viridanus* (Blyth): Specimen obtained at Ambarnath, Kalyan, Kolaba dist. is dated 1 July 1962 and appears exceptionally early.

1606 *Phylloscopus occipitalis occipitalis* (Blyth): Specimen Coll. No. 1932–Funnel Hill (Karnala), Panvel is dated 21 June 1965 which also appears very early but may only be an indication of our lack of knowledge of the movements of these birds.

A. NAVARRO
December 2, 1986. S. UNNITHAN

## 28. THE DESERT WHEATEAR *OENANTHE DESERTI* IN MADRAS

On the afternoon of 30 November 1986, while watching birds at the meadow on the northern banks of the Adayar Estuary, I was caught in a sudden cloudburst. As I stood still, waiting for the rain to subside, I noticed on a bare branch of a *Prosopis* bush, a small bird, about the size of a sparrow. I was close enough to get a brief but unmistakeable view of the bird to identify it as a male Desert Wheatear *Oenanthe deserti*. The bird suddenly took off, hovered like a flycatcher briefly, revealing its black and white tail pattern before flying away.

On the afternoon of 6 December 1986, however, I located the bird again, and observed it closely. There was no doubt whatsoever as to its identity. The bird was pale sandy buff on the crown, nape and back. The sides of the head, chin and throat were black, slightly speckled with white. The wings appeared to be black from a distance but a closer look revealed that they were dark blackish–brown. The upper tail coverts and basal half of the tail were white, contrasting with the otherwise black tail. The underparts were pale buff. A pale supercilium bordered the black over the eyes and the dark wings also had a whitish border. The bill and legs were dark.

The bird was seen mostly on the ground and at times, perched on small stones or atop bare branches of *Prosopis* or *Calotropis* bushes, invariably flicking its tail, flashing the contrasting tail pattern. Most of the feeding was done on the ground, although at times, the bird indulged in short flycatching sorties. On the ground, it would run in short spurts, sideways, at an angle. It would stop now and then, stretch its neck and be on alert lookout, while the tail kept flicking up and down in a manner reminiscent of a pipit or wagtail. Foraging was done in the sandy area or grassy patches and mostly small insects were devoured.

The wheatear appeared to be a loner and there were no signs of another of its species anywhere in the locality. I have seen wagtails feeding close to the wheatear and occassionally they chased each other. I also observed in one instance, a Common Swallow *Hirundo rustica* pursuing the wheatear. On 10 January 1987 I heard the bird calling in a quiet and subdued manner and subsequently these warblings were heard on a couple of occassions. Apart from this, the bird did not call and was silent throughout.

The bird appeared to be parochial, keeping to the same portion of the meadow day after day. Only once did it shift its territory to another part of the meadow. I was quite surprised at the tameness of the bird. It allowed me to approach it as close as 8–30 feet and I photographed it at this distance.

The Desert Wheatear is mainly a winter visitor to Pakistan and India and the southernmost records of this species are from central Maharashtra (Poona, Ahmednagar) and northern Andhra Pradesh (Nirmal) (Ali and Ripley 1983). In view of this fact, the occurrence of this species in Madras city, far from its usual winter range is noteworthy. The bird was seen in Madras at the same locality for over months and was last seen on 1 February 1987. Thereafter, the site was visited on 14 February 1987 and 15 February 1987 but the bird was not to be seen.

June 9, 1987. V. SANTHARAM

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## 29. TREECREEPER (CERTHIIDAE) NESTING IN WESTERN NEPAL

A late spring trek in 1985 afforded me the opportunity to gather nesting data on birds in the remote and rugged Lake Rara–Jumla area of western Nepal.

On 9 May 1985, I observed a pair of nesting Common Treecreepers *Certhia familiaris mandelli* while travelling northwest from the regional center of Jumla. This record occurred at approximately 3250 m elevation, some 400 m beyond the hamlet of Thahamari, and 15 m from the main trail that traverses the north slope of Dori Lekh.

The nest was located at a height of 5 m in a trunk crevice of a dead fir *Abies spectabilis*, which unfortunately could not be closely examined. Nonetheless, it was evident that chicks were present, as both parents busily foraged lepidopteran larvae and small insects. One parent would remain on the nest, occasionally poking its head out of the crevice, until the other returned with food, whereupon the waiting parent would immediately dart off in search of prey. I returned to this site on 20 and 21 May 1985 after completing a circuit to the north. There was no further activity at the nest, but on 21 may a single treecreeper, most likely *C. f. mandelli* although not positively identified was noted briefly in the vicinity high up a conifer.

Habitat at this site is mixed montane forest of fir *A. spectabilis* and birch *Betula utilis* with scattered maple *Acer* sp., and a relatively open understorey of saplings, shrubs and bamboo *Arundinaria* spp.

*C.f. mandelli* ranges from the Kulu region of northwest India across the Nepalese Himalaya to extreme western Arunachal Pradesh (Tawang; Ali and Ripley 1973). Its abundance has been variously reported as occasional (Fleming *et al.* 1984), fairly common (Inskipp and Inskipp 1985), and common (Ali and Ripley 1973). However, few breeding data exist for this treecreeper subspecies. Nest building in an old fir stump at 3355 m was recorded by Polunin on 19 April 1952 at Punga Lekh, Jumla district (Inskipp and Inskipp 1985). Juveniles independent of parents were collected at 3950 m and 4200 m in Khumbu, East Nepal in June 1962 (Diesselhorst 1968). Thus, this most recent breeding record is similar to those previously noted with respect to nesting habitat, elevation, and temporal activity.

Also on 9 May 1985, but further northwest of Dori Lekh along the Khapar Khola, I noted nesting activity of the Himalayan Treecreeper *C. himalayana infima* near Bumra village at about 2740 m. A single bird, presumably a female, was observed in an open riverside grove hitching up a walnut *Juglans regia* tree with a beakful of short yellow grass. A pursuing Sparrow Hawk *Accipiter nisus* thrice attempted to grab her by clumsily manoeuvering through the branches, but each time the treecreeper successfully evaded the raptor by sidling around the walnut trunk, until it flew off unnoticed.

The four certhiid species in Nepal all occur in the far western region. However, the Brown–throated Treecreeper *C. discolor discolor* and the Rusty–flanked Treecreeper *C. nepalensis* are primarily eastern Himalayan species, sparsely distributed at the western limits of their ranges (Inskipp and Inskipp 1985). Niche distinctions between the more common *C.f. mandelli* and C. h. infima remain poorly understood, although the former appears to favour higher altitude mixed conifer forests where associated rhododendron *Rhododendron* spp. is replaced with birch (Martens 1981, Inskipp and Inskipp 1985). Clearly, further study of certhiid ecology in western Nepal, especially breeding biology and factors affecting competitive exclusion, is needed.

September 26, 1987. JACK H. COX

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## 30. FOREST WAGTAIL *MOTACILLA INDICA* AT JASDAN, GUJARAT

On 19 November 1987 I saw a single Forest Wagtail Motacilla indica in my compound. The bird was seen again on 21st and 22nd and I managed to catch it in a mist net on 23 November 1987 and ring it (ring No. A. 39294). This bird is a rare winter visitor to Gujarat.

November 28, 1987. SATYAJIT KHACHAR

## 31. HOST PLANTS USED BY BAYA WEAVER BIRD *PLOCEUS PHILIPPINUS* (L.) FOR NESTING IN UDAIPUR DISTRICT, RAJASTHAN

During the breeding season of 1986, I surveyed some parts of Udaipur District of Southern Rajasthan to study the free preference of *Ploceus philippinus* for nesting. I travelled on foot or cycle and sometimes by motorcycle along the different roads in the district. I surveyed a 50 m wide strip of land on either sides of the 200 km. long road in different localities including some forest areas like the Keora Ki Nall Reserve Forest and Banki Block of Udaipur (south) Division and Jaisamand Wildlife Sanctuary. My findings are as below (Tables 1 & 2).

TABLE 1

DICOT HOST PLANTS USED FOR NESTING

| | Family of preferred plant | Preferred plant | Number of plants used for nesting |
|---|---|---|---|
| | CAPPARIDACEAE | *Capparis sepparia* | 1 |
| | MELIACEAE | *Azadirachta indica* | 2 |
| | RHAMNACEAE | *Zizyphus mauritiana* | 13 |
| | LEGUMINOSAE | *Acacia nilotica* var. *indica* | 98 |
| | | *Acacia leucophloea* | 39 |
| | | *Prosopis spicigera* | 6 |
| | | *Prosopis juliflora* | 2 |
| | | *Albizzia lebbek* | 1 |
| | | *Tamarindus indica* | 1 |
| | | *Butea monosperma* | 7 |
| | | *Bauhinia racemosa* | 2 |
| | | *Dichrostachys cinerea* | 2 |
| | | *Pithecolobium dulce* | 4 |
| | ULMACEAE | *Holoptelia integrifolia* | 6 |
| | MORACEAE | *Ficus religiosa* | 1 |
| | RUTACEAE | *Aegle marmelos* | 1 |
| | EBENACEAE | *Diosphyros cordifolia* | 2 |
| | ANACARDIACEAE | *Lenia grandis.* | 2 |
| | SANTALACEAE | *Santalum album* | 2 |
| | ANONACEAE | *Anona squamosa* | 1 |
| | SIMAROUBIACEAE | *Ailanthus excelsa* | 2 |
| **Total:** | 12 families, | 19 genera, 21 species, | 195 |

TABLE 2

MONOCOT HOST PLANTS USED FOR NESTING

| | Family of preferred plant | Preferred plant | Number of plants used for nesting |
|---|---|---|---|
| | Palmae | *Phoenix silvestris* | 50 |
| | Gramineae | *Dendrocalamus strictus* | 1 |
| **Total:** | 2 families, | 2 genera,<br>2 species, | 51 plants. |

It can be seen from Table 1 that *Acacia nilotica* var. *indica* is the most preferred plant for nesting followed by *Phoenix silvestris* and *Acacia leucophloea*. It is also clear from Tables 1 & 2 that a number of forest species can be selected for nesting.

## ACKNOWLEDGEMENTS

I am grateful to Mr U.M. Sahai, I.F.S., Dy. Conservator of Forest, Udaipur (North) Division for his encouragement. My thanks are also due to Mr Balvant Singh Kanthalia, Forester, and Mr. Ajat Shatru Singh Bhatti, Forester, who have helped me in collection of some data.

August 18, 1987. SATISHKUMAR SHARMA

## 32. HOST PLANTS USED BY BLACKTHROATED WEAVER BIRD *PLOCEUS BENGHALENSIS* FOR NESTING IN SOME DISTRICTS OF RAJASTHAN AND HARYANA

TABLE 1
LIST OF AREAS STUDIED

| State | District | | Areas studied |
|---|---|---|---|
| Rajasthan | Alwar | (i) | Alwar to Bharatpur border at S.H. 14. |
| | | (ii) | 120 ha. plantation area of Forest Deptt. near village Tatarpur (27 ° $47'N, 76° $31'E) |
| | | (iii) | River Sabi from village Sodawas to Sabi bridge. |
| | Bharatpur | (i) | Alwar border to Bharatpur at S.H. 14. |
| | | (ii) | Halena to Bharatpur at N.H. 11. |
| | | (iii) | Some patches in Keoladeo National Park, Bharatpur. |
| | Sikar | (i) | Ringus to Sikar railway line. |
| | Jaipur | (i) | Kotputli to Jaipur at N.H. 8. |
| | Dungarpur | (i) | Almost whole district. |
| Haryana | Mahendra Garh | (i) | Area of 200 m radius around Station Mazri on Jaipur–Delhi railway line. |
| | | (ii) | Rewari to Mahendra Garh railway line. |
| | Gurgaon | (i) | Rewari to Gurgaon railway line. |

(NH = National Highway, SH = State Highway)

This note deals with a field study on the preferred plants used by the Blackthroated Weaver Bird *Ploceus benghalensis* for nesting. The preferred host plants were surveyed in the many districts of Rajasthan namely Alwar, Bharatpur, Sikar, Jaipur, Dungarpur, Chittor Garh, Banswara and two districts of Haryana, Mahendra Garh and Gurgaon.

Details of areas studied during the host plant survey are given in Table 1.

I concentrated my attention on 50 m wide strips of land on either side of the roads, railway lines and main river courses. A 50 m wide strip of land was also surveyed around water bodies. My observations are as shown in Table 2.

It is generally believed that Blackthroated Weaver Birds use grasses and other grass like monocotyledons to hang their non — pensile nests. But in cases of scarcity of grasses and other grass–like monocots, Blackthroated Weaver Birdshang their nests on dicots also as observed near Rly. Station Mazri in Haryana. At this particular site suitable tall grasses could not be traced. It is interesting to note that at this particular site the birds hung their nests at an average height of 1 m from ground level on dicot hosts, similar to host grasses.

A detailed survey was conducted in district Chittor Garh, Banswara and Udaipur in Rajasthan but no nesting was observed.

July 30, 1987. SATISH KUMAR SHARMA

TABLE 2

HOST PLANTS PREFERED FOR NESTING BY BLACKTHROATED WEAVER BIRD *Ploceus benghalensis*

| Group of plants | Family of preferred plant | Preferred plant used for nesting | No. of preferred plants/clumps used for nesting in various districts in different breeding seasons | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Alwar | | | Bharat-pur | Sikar | Jaipur | Dungarpur | | Mahendra Garh | Gurgaon |
| | | | 1982 | 1983 | 1987 | 1980 | 1987 | 1987 | 1987 | 1984 | 1987 | 1987 |
| Monocots | Typhaceae | *Typha angustata* | 1 | | 3 | - | 6 | - | - | - | - | -- |
| | Gramineae | *Saccharum munja* | 85 | 91 | 61 | 74 | 76 | 96 | 4 | - | 40 | 65 |
| | | *S. spontaneum* | 11 | 8 | - | - | - | - | - | - | - | - |
| | | *S. officinalis* | - | - | - | 1 | - | - | - | - | - | - |
| | | *Sorghum vulgare* | - | 1 | - | - | - | - | - | - | - | - |
| | | *Penninsetum typhoides* | 1 | 1 | - | - | - | - | - | - | - | |
| Dicots | Convoloulaceae | *Ipomoea fistula* | - | - | - | - | - | - | - | 4 | - | - |
| | Leguminosae | *Acacia nilotica* | - | - | - | - | - | - | - | 2 | - | - |
| | Rhamnaceae | *Zizypus jujuba* | - | - | - | - | - | - | - | 1 | | -- |
| **Total:** | 5 families | 7 genera, 9 species | 98 | 104 | 61 | 81 | 76 | 96 | 4 | 7 | 40 | 65 |

## 33. HALF–BUILT NESTS OF BLACKTHROATED WEAVER BIRD *PLOCEUS BENGHALENSIS* WITH DOUBLE CHIN STRIPS

*(with two text-figures)*

Half built nests of Blackthroated Weaver Bird normally *Ploceus benghalensis* and other species of weaver birds have only one chin strip, which creates two openings in the half–built nest at helmet stage. During a survey in the 1983 breeding year in Alwar district of eastern Rajasthan. I found 8 abnormal half–built nests of *P. benghalensis* in clumps of *Saccharum munja* in different localities of this district. Seven of these nests had double chin strips, while the eighth was without a chin strip.

Each of the nests with double chin strips was observe carefully. Each was formerly a normal nest with a single chin strip, but perhaps due to rejection of the whole nest or at least rejection of the egg – chamber (partial rejection) by the female, former chin strips were darned by the cocks with the ceiling of respective nests. Simultaneously they prepared an additional chinstrip upwardly, parallel to the original chin strip to create a new egg chamber within the old nest. Once a nest is completed separate identity of primary chin strip cannot be visualized.

August 18, 1987. SATISH KUMAR SHARMA

## 34. GREYNECKED BUNTING *EMBERIZA BUCHANANI* BLYTH SIGHTED NEAR UDAIPUR, RAJASTHAN

On the outskirts of Udaipur city, Rajasthan,is a small hill called 'Neemach Mata', which is surrounded by flat land having open scrub. We were trekking in this area on 9 April 1987 and at about 1300 hrs, we noticed a bird of House Sparrow size silently feeding on the ground under the shade of an *Acacia nilotica* (Babul) tree. A few paces away from the bird a male Crested Bunting *Melophus lathami* was feeding on the ground. The distinct style of

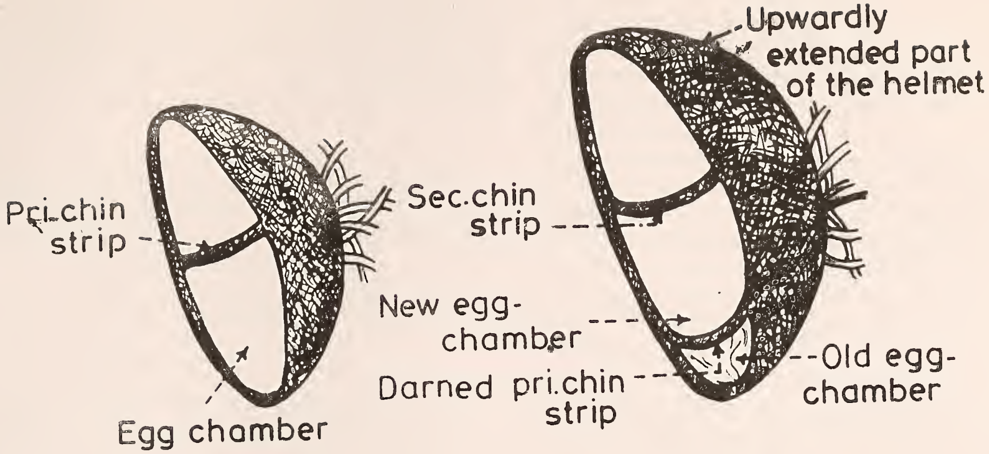
Pri.chin strip
Egg chamber
Sec.chin strip
New egg-chamber
Darned pri.chin strip
Upwardly extended part of the helmet
Old egg-chamber

Fig. 1: Half built nest of Ploceus benghalensis showing formation of Secondary chin strip.

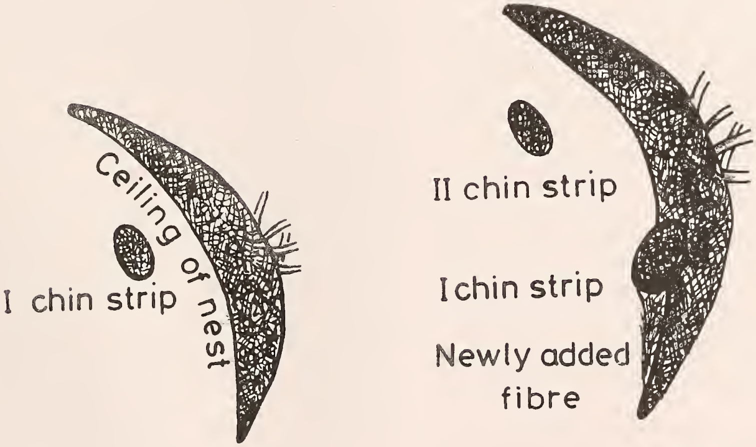
Ceiling of nest
I chin strip
II chin strip
I chin strip
Newly added fibre

Fig. 2: Darning of first chin strip with ceiling of nest is being looked in V.S. view of half built nest of Ploceus benghalensis.

movement of the bird caught our attention from a distance of about 50 m. On focussing our binoculars we were surprised to find grey colour on the head and flanks of the neck and a very distinct white ring around the eyes. Moustachial streaks were also very prominent. The rest of the body on ventral side was light brownish in colour. The dorsal side was very much like that of a sparrow, but with darker streaks on the folded wings meeting over the rump. The tail was forked and during flight white coloration of the outer retrices could be observed. Colour of the beak brownish yellow and legs were almost brown. On 10 April 1987 it was again seen at the same place feeding from 1200 to 1600 hrs. On intrusion it took refuge on the *Babul* tree. We kept a watch over the bird's activities and found it feeding at the same place from 9 to 19 April 1987. Thereafter it left the place. We consulted the HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN (Compact Edition) (Ali & Ripley) and concluded that the bird was a Greynecked Bunting.

RAZA TEHSIN
MANOJ KULSHRESHTHA
RAVINDER SINGH

July 30, 1987.

## 35. FOUR ADDITIONS TO THE BIRDS OF KERALA

Out of the 300 and odd species of birds belonging to the Order Charadriformes (waders, gulls, terns etc.), only 41 species are included in THE BIRDS OF KERALA by Salim Ali (Oxford University Press, 1968). The status of some among these 41 species is still quite uncertain. During a study conducted in the Kadalundy estuary from September 1985 to June 1986, we discovered at least four species hitherto unrecorded in Kerala. We have also earlier observed 3 species recorded as very uncommon in Kerala before.

Kadalundy is about 20 km south of Calicut, (11° 05' N, 75° 51'E). Here the Kadalundy river originating in the Karuvarakundu forests west of the Silent Valley, joins the Arabian sea. The river mouth is blocked in part by a coastal sandbar, thus forming a lagoon undisturbed by the turbulence of the sea. A railway line cuts across the estuary. Our study was conducted mainly in the 60 acre wetland between the railway line and the sea. During low tide, about 25 acres of mudflats become exposed.

We paid about 45 visits to Kadalundy, jointly or separately, between September 1985 and June 1986. We observed in the study area more than 30 resident birds and 50 migrants. We did not attempt to identify several warblers seen there. Of the birds not included in THE BIRDS OF KERALA or reported later in *J. Bombay nat. Hist. Soc.*, only those we could identify for certain are described in this note.

**Sandwich Tern** *Sterna sandvicensis*: Our most exciting find in Kadalundy was the Sandwich Tern. There are only two previous records of this bird in India. In 1958, Dharmakumarsinhji observed it near Varaval Coast in Saurashtra (*JBNHS 55*:35). In 1976, C.K. Krishnaprasad of Cherai near Cochin shot a Sandwich Tern bearing a ring put on it at Krasnovodsk Reserve, Krasnovodsk Gulf, Caspian Sea, Turkmenian SSR, USSR.

The Sandwich Tern was first observed in Kadalundy by one of us (LN) on 6 October. The bird was seen in fairly large numbers during all our subsequent visits. From January to March they were present in hundreds. On 10 March we estimated their numbers at 500. Sandwich Terns were always seen along with Large Crested and other terns, and sometimes in large mixed flocks of terns and gulls. Never did we observe Sandwich Terns fishing in the Kadalundy Estuary. It appeared that they went for fishing to the open sea in the mornings and evenings and came to the estuary to rest during the hot hours of the day. By about 0800 hrs one could see small parties of Sandwich Terns coming from the west (the Arabian sea). By about 1600 hrs they flew back in the opposite direction. The black bill with yellow tip and black legs were distinctly observed.

On 27 March there was a large number of Sandwich Terns in Kadalundi. But they were absent on 5 and 19 April. Surprisingly, LN saw 4 Sandwich Terns on 1 June.

**Grey Plover** *Pluvialis squatarola*: The Grey Plover has not been recorded in Kerala and is not mentioned in THE BIRDS OF KERALA. On 5 October, LN observed one Grey Plover in Kadalundy. On 16 November there were 3, and on 24 November, 10. Thereafter the Grey Plover was regularly seen in Kadalundy in fairly large numbers. It was last seen on 10 March. At times there were flocks of about 25 birds feeding or resting at the edge of the water, sometimes even in water a few inches deep. Grey Plovers always kept near the edge of the water, unlike Golden Plovers, which were also seen in fairly large numbers, and favoured the eastern half of the mudflats dotted with reeds and a few emergent mangroves. We never observed any interaction between these two plovers in Kadalundi.

PKU has taken pictures of Grey Plovers showing the identification marks, black armpits and white rump, clearly. We have also observed this bird in Calicut north and in Badagara Sandbanks (40 km north of Calicut) and also in the Azheekal estuary near Cannanore. Prof. K.K. Neelakantan saw the Grey Plover near Trivandrum at Perumathurai, a bird with vestiges of breeding plumage on 6 October 1973 and a few at Poovar on 19 November 1978, 22 January 1979, and 28 January 1979 (Pers. comm.). From these observations it can be safely deduced that the Grey Plover is not an uncommon winter visitor to the Kerala coast.

**Dunlin** *Calidris alpina:* Salim Ali says in THE BIRDS OF KERALA, "No doubt the Dunlin *Calidris alpina* (Linnaeus) also winters in Kerala with mixed flocks of small waders on the sea coast, but has been overlooked." From 7 November 1985 to 27 March 1986, the Dunlin was seen regularly in Kadalundy. We have estimated 20–30 birds feeding with other small waders like the Terek Sandpiper, the Curlew Sandpiper, the Turnstone, the Lesser Sandplover, the Kentish Plover, the Little Stint, and the Temminck's Stint. The Curlew Sandpiper and the Dunlin were seen side by side and could easily distinguish them by comparing the curvature of the bills. The bill of the Dunlin is only slightly downcurved at its tip. This bird used to feed all over the exposed mudflat. At least in Kadalundy the Dunlin is a common winter visitor.

**Bartailed Godwit** *Limosa lapponica:* Neither the Black-tailed nor the Bartailed Godwit has been recorded previously in Kerala. The Bartailed Godwit was first seen in Kadalundy on 7 November. Its number was never high in Kadalundy. On 15 November, 6 birds were observed, and on 29 November LN saw 10. This was the largest number ever seen. Usually Bartailed Godwits were seen resting and preening among other waders, almost always near the waterline and sometimes even in shallow water. On 8 December LN saw one Bartailed Godwit feeding in the estuary. This species was not seen in Kadalundi after 23 December.

**Temminck's Stint** *Calidris temminkii:* In THE BIRDS OF KERALA, Salim Ali says: "Although the Temminck's Stint has not been recorded from Kerala, it is more than likely that it occurs in winter along with the Little Stint". The occurrence of the Temminck's Stint was recorded by Dr A.J. Gaston from Cheruthuruthy, in Bharatapuzha (*JBNHS 2:* 28). Even though we might have seen the Temminck's Stint earlier, we identified the bird first on 19 January. Along with the Little Stint was another bird of the same size and with the same type of bill, but with yellowish brown legs and brownish breast. We could also note the white outer tail feathers.

As Temminck's Stints always associated with Little Stints, it was easy to estimate their approximate number, which was definitely not very high. The Temminck's Stint was seen in Kadalundy till 5 April.

**Oystercatcher** *Haemantopus ostralegus:* Even though the Oystercatcher is included in THE BIRDS OF KERALA, there are very few sight records of this bird in Kerala. It was last reported by Jerdon from the Tellicherry coast. In 1980 September LN saw a single Oystercatcher on Calicut beach for a few days.

On 15 September 1985, all three of us were watching birds in the Kadalundy estuary. On that day, with the migration at its peak, the estuary was teeming with waders, including a number of curlews and Whimbrels. By about 1030 hrs two Oystercatchers appeared in the shallow waters in the western part of the estuary. After staying there for only a few minutes, the birds took to their wings, presumably disturbed by passing country boats. Within those few minutes during which we could observe them, PKU took a few pictures of the Oystercatchers clear enough for record purposes. Later in the season LN and C. Sasikumar of Cannanore saw 5 Oystercatchers in the Azheekal estuary near Cannanore, but they were not seen at Kadalundy after 15 September. Sasikumar has since regularly seen Oystercatchers in Azheekal. The largest number seen by him was 14 (pers. comm.).

**Lesser Blackbacked Gull** *Larus fuscus:* According to THE BIRDS OF KERALA, there is only one record of the Lesser Blackbacked Gull from the Kerala coast. Throughout the migration season, thousands of gulls occur at Kadalundy estuary. On 12 January, in the midst of a large flock of Brownheaded Gulls and Lesser Blackheaded Gulls, six large sized gulls with dark mantles were seen. The Lesser Blackbacked Gull was seen again on 25 January and on 2 February. This gull is only an occasional visitor to the Kadalundy estuary, like the Great Blackheaded Gull seen for a few days in March.

In variety and concentration of birds, especially of waders and terns, the Kadalundi estuary surpasses any similar area we have seen in Kerala. Surely it is a unique bird habitat, and, as such, it has to be properly protected. We persuaded the district administration to put up a notice board prohibiting the shooting of birds in Kadalundy, but a lot more remains to be done by was of research and conservation action. We are grateful for the financial assistance provided by the Dept. of Environment, Govt. of India.

L. NAMASSIVAYAN
P.K. UTHAMAN
R. VENUGOPALAN

July 17, 1987.

## 36. SOME OBSERVATIONS OF SCARCE BIRDS IN KERALA AND TAMIL NADU

In January and February 1985 we, together with N. Simpson, visited southern India to watch birds. A variety of habitats was visited and in particular our attention was concentrated on the endemic avifauna (Harrap and Redman *in prep.*). Observations were also made of four species which are scarce or previously unrecorded in Tamil Nadu and Kerala, and these are documented below. The opportunity has also been taken to include recent related records by other observers (all records are the authors' unless otherwise indicated).

**Redwinged Crested Cuckoo** *Clamator coromandus*: One was seen 16 Km west of Munnar, Kerala, on 31 January 1985 near the Cochin road at about 1000 m on the southern flanks of the High Range. It was moving slowly through ground–storey vegetation in evergreen forest.

Its status in the peninsula is 'very imperfectly known or understood' (Ali & Ripley 1983). For Kerala, Ali (1969) gives a suite of records indicating that it is a scarce but regular winter visitor throughout the state. Our sighting fits well with this pattern.

**Kashmir Redbreasted Flycatcher** *Muscicapa subrubra*: A male was seen by R. Grimmett and C. Robson at Ootacamund (Ooty) in the Nilgiri Hills, Tamil Nadu, at about 2250 m on the edge of a relict stand of montane forest amidst pine and eucalyptus plantations on 4 and 5 February 1984, and a female was seen there on the latter-date. Two males were observed by us at the same site on 8 February 1985, with another two males 3 km away on the edge of scrub adjacent to the Avalanche road. Finally, a male was observed at the original Ooty site by K. Derbyshire and J. Eames on 10 December 1986.

The males were easily distinguished from Redbreasted Flycatcher *M. parva* by extensive orange–red on the throat, breast and upper belly, bordered by a black line along the lower edge of the ear coverts and the sides of the breast, extending diffusely onto the flanks. Notably, the head and mantle were smoky blue–grey and the bill conspicuously pinkish–orange, only slightly darker along the culmen, features not adequately covered by Ali & Ripley (1983) where the male is described as dark grey–brown above and the bill brown, with only the lower mandible yellow.

The Kashmir Redbreasted Flycatcher winters in Sri Lanka above about 750 m in gardens, tea estates, borders of forest etc., but is scarce on passage in the peninsula and apparently not previously recorded in Tamil Nadu or Kerala (Ali & Ripley 1983). The presence of birds at Ooty in three different years indicates that the species wintersregularly in the Nilgiris, and perhaps the whole of the Western Ghats complex. Why it should have been previously unrecorded is not clear, though S.C. Madge (in litt.) notes that some males are poorly marked and easily passed off as *M. parva.*

**Tytler's Leaf Warbler** *Phylloscopus tytleri*: Two birds were observed above Vagavurrai, 20 km northeast of Munnar, Kerala on 2 February 1985 at about 2000 m on the slopes bordering the Eravikulam Plateau. They were feeding actively in the middle–storey on the edge of a *shola.* Due to the difficulties of identifying *Phylloscopus* warblers, their appearance will be discussed in detail.

*Description:* Size and shape similar to a Dull Green Leaf Warbler *P. trochiloides* (i.e. about 10 cm). Crown, mantle, rump and wing coverts dull olive–grey. A narrow but well–defined whitish supercilium contrasted with the dark eyestripe. Remiges and rectrices dark olive–brown, on one individual fringed bright olive–green. Underparts off–white lightly sullied with grey, and with a touch of yellow in the centre of the breast and on the undertail coverts. Bill not noticeably long, but slender, blackish and with a very small pale base to the lower mandible. Legs mid– to pale grey. Call a hoarse, squeaky *huweest.*

*Discussion:* In fresh plumage, Tytler's Leaf Warbler is greyish–olive above, remiges and rectrices dark brown fringed with olive–green, underparts yellowish–white streaked brighter yellow. In first winter plumage they are greener above and yellower below. Worn birds are grey–brown above and dirty white below (Ticehurst 1938, Williamson 1967, Inskipp & Inskipp 1985). Particularly, in worn plumage, confusion is possible with Largebilled *P. magnirostris*, Dull Green *P. trochiloides* and Bright Green Leaf Warblers *P. (t.) nitidus*, all of which are common winter visitors to peninsular India. All three species can be excluded by a combination of the following characters:

1. Absence of wingbar. The three species show a narrow pale wingbar on the tips of the greater coverts, although in worn plumage this may be absent. The bright green fringes to the remiges of one of the Vagavurrai birds indicate that these feathers and their coverts were relatively fresh and unabraded and that they did not therefore show wingbars in fresh plumage.
2. Slender, all–dark bill. Inskipp & Inskipp (1985) state that a more slender and all–darkish bill separates Tytler's from a worn Dull Green Leaf Warbler, and indeed Dull Green (of the forms *ludlowi* and *viridanus*) and Bright Green Leaf Warblers always show a prominent pale base to the lower mandible. However, *P. t. trochiloides*, which is rare south of the Gangetic plain, can show a

predominantly dark lower mandible (pers. obs. and R. Grimmett *pers. comm.*). Interestingly in this context, Alexander (1955) gives details of Dull Green Leaf Warblers seen at Ootacamund with all–darkish bills. The Largebilled Leaf Warbler has a long and stout bill, the lower mandible with a variable pale base, although usually darker in the breeding season and dark in skins (Ticehurst 1938). Statements in the literature that Tytler's Leaf Warbler has a very long bill appear to be erroneous; it is only marginally, if at all, longer than that of the dull Green Leaf Warbler (12–14 mm for Tytler's, 11.5–14.5 mm for Dull Green (Ticehurst 1938, Williamson 1967). The slender profile is, however, distinctive.

3. Call — all three species can be excluded by call. The Largebilled Leaf Warbler has a very distinctive, stereotyped call (Ali & Ripley 1983 and pers. obs.). Bright and Dull Green Leaf Warblers share very similar, unequivocally disyllabic calls, a *chee—wee* or *tiss—yip* (Dean 1985 and pers. obs.). Unfortunately we are unfamiliar with the call of Tytler's Leaf Warbler, which is usually described as a single feeble note and a double *y—it* (Inskipp & Inskipp 1985).

The winter range of Tytler's Leaf Warbler is poorly known, but the few records include two from the Nilgiris and it is generally believed to comprise the Western Ghats complex (Ali & Ripley 1983). Our observations support this hypothesis. The difficulty of identifying birds in their winter quarters perhaps explains the dearth of records.

**Dark Thrush** *Turdus obscurus*: One was seen on 4 February 1984 by C. Robson at Ootacamund at about 2250 m in a relict stand of montane forest amidst pine and eucalyptus plantations. One was seen on 23 January 1985 by SCH at Point Calimere, Tamil Nadu, in scrub immediately inland of the coast. The combination of a prominent pale supercilium and variable buff or peachy flanks and breast and distinguish this thrush.

The Dark Thrush is a common winter visitor to the Indian subcontinent from Bangladesh eastwards. The above records appear to be the first from Tamil Nadu but, together with four recent winter records from Nepal (Inskipp & Inskipp 1985) and a record from northwest Karnataka (Ali & Ripley 1983), may indicate that the species is a rare, but regular straggler to other parts of the subcontinent.

ACKNOWLEDGEMENTS

We would like to thank R. Grimmett and C. Robson for their expert advice in planning our trip and provision of their records. J. Eames also supplied us with details of his observations and S.C. Madge kindly commented on a draft of this note.

October 29, 1987.

S.C. HARRAP
N.J. REDMAN

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## 37. ADDITIONAL RECORD ON MORTALITY FROM HAILSTORM AT JAIPUR

On 8 May 1987, at around 1630 hrs, a heavy hailstorm hit some parts of Jaipur city, Rajasthan. The effect of this hailstorm, which lasted more than an hour, was very severe inside the campus of Rajasthan University at Jaipur. The weight of the hailstones varied from 100 to 150 gm. Considerable damage was caused to the fauna and flora of this area. A number of trees like *Polyalthia longifolia, Delonix regia, Cassia fistula, Azardirachta indica* were damaged. The next morning we recorded dead bodies of several species of common birds and some mamals. They were Indian Peafowl *Pavo cristatus*, Red wattled Lapwing *Vanellus indicus*, Common Myna *Acridotheres tristis*, Roseringed Parakeet *Psittacula krameri*, Ringdove *Streptopelia decaocto*, Blue Rock Pigeon *Columba livia*, House Crow *Corvus splendens*, House Sparrow *Passer domesticus*, Spotted Owlet *Athene bramma* and Five–striped Palm Squirrel *Funambulus pennanti*.

October 18, 1987.

B. RAM MANOHAR
M. RAJASEKARAN

## 38. CATTERPILLAR IN DIET OF HOUSE GECKO

The food of the House Gecko *Hemidactylus flaviviridis* consists mainly of insects. Smaller insects are swallowed whole, whereas larger victims are battered to death and then eaten (The Book of Indian Reptiles, J.C. Daniel, p. 36). The gecko has been observed catching moths, butterflies and a variety of insects.

In the evening of 15 February 1988 a gecko was hunting insects on a wall adjacent to a bed of chrysanthemum flowers, when it noticed a black caterpillar with yellow spots on one of the plants very close to the wall. Without much difficulty it caught the caterpillar and swallowed it. This is the first such instance noticed by me.

April 11, 1989. ARUN M.K. BHAROS

## 39. REDISCOVERY OF HOLOTYPE OF *TROPIDONOTUS STRIOLATUS* BLYTH, 1868 (SERPENTES: COLUBRIDAE) IN THE COLLECTION OF THE ZOOLOGICAL SURVEY OF INDIA

*(With a plate)*

*Tropidonotus striolatus* was described by Blyth (1868), based on a single well–preserved specimen of colubrid snake from the Andaman Islands, collected by Capt. Col. R.C. Tytler. Although currently considered a synonym of *Xenochrophis piscator* (Schneider 1799), Theobald (1868) in his "Catalogue of the Reptiles in the Museum of the Asiatic Society of Bengal" considered the species as distinct and gave a detailed description of the species. Later Theobald (1876 : 175—176), in his "Descriptive Catalogue of the Reptiles of British India" again supported the separate status of the species based on this type.

Smith (1943), who examined the entire collection of the Indian Museum, Calcutta, prior to this publication, called attention to the fact that the type of *Tropidonotus striolatus* later synonymised with *Xenochrophis piscator* was lost. The purpose of this communication is to announce the rediscovery of the holotype of *Tropidonotus striolatus* Blyth in the collection of the Zoological Survey of India, Calcutta.

The holotype was originally deposited in the collection of the Asiatic Society of Bengal (A.S.B. 46 a), which became a part of the collections of the Indian Museum (Calcutta) in 1880 as I.M. 7402. The zoological accessions in the Natural History section of the Indian Museum were then transferred to the Zoological Survey of India, Calcutta, in July 1916. The holotype is an adult male from the Andaman Islands which was catalogued in volume II of the Register of Presentations to the Indian Museum on 20 August 1880 with the registration No. 7402 (A.S.B. 46 a). The standing of this specimen as the type of *Tropidonotus striolatus* must now be examined. The evidence concerning the type status of the specimen is as follows:

i) The registration register and the label afford the biomen *Tropidonotus striolatus*, and the accession to the Indian Museum collection of the specimen on 20 August 1880,is consistent with the date on which the species was described (1868).

ii) There is a specific entry 'Type' in the registration register against the accession number.

iii) The holotype agrees well with Blyth's original description of the species, and the data on the label and the registration number are consistent.

iv) Further evidence of critical number is provided by thefollowing statements in the Annual Report for 1910—11 ofthe Indian Museum (Annandale 1911):

"The following 'Type' specimens of new genera and species, subspecies and varieties have been added to the collection of the Indian Museum during the year:

Reptilia

*Tropidonotus piscator* type of *Tropidonotus striolatus* Blyth.

This type was deposited in the Indian Museum in the spirit of the resolution adopted at a Conference as regards Museums in India, held in Calcutta during December 1907, 'that all zoological types in India shall be deposited in the Indian Museum' (Anonymous 1908)"

In view of Smith's categorical statement that the type of *Tropidonotus striolatus* Blyth was lost, it was considered necessary to draw the attention of herpetologists to the continued existence of the type.

The holotype of *Tropidonotus striolatus*, presently known as *Xenochrophis piscator* (Schneider) from the Andaman Islands, was described as having 19 rows of keeled scales, 141 ventrals, 85 subcaudals, one pre—and 3 or 4 postoculars, 9 supralabials, one large and square loreal; the anal is divided. The specimen (ZSIC 7402) in our collection has the same pholidosis, clearly indicating that this is the same Andaman specimen. It is still in a fairly good state of preservation. Its current taxonomic status is:

**Xenochrophis piscator** (Schneider)

*Hydrus piscator* Schneider, 1799, *Hist. Amph., 1:* 247 (East Indies; based on Russell's "Neeli Koea").

*Tropidonotus striolatus* Blyth, 1868, in Theobald's *Cat. Rept. Mus. Asiat. Soc.:* 55 (Andaman Islands), and *Rept. Brit. India,* 1876: 175.

*Natrix piscator piscator* Smith, 1940, *Rec. Indian Mus., 42:* 383.

*Material examined:* Holotype an adult male, 1020 mm in standard (snout—vent) length, tail 300 mm; loc., Andaman Islands (India); Coll. Capt. Col. R.C. Tytler; Zoological Survey of India Regd. No. 7402 (46 a A.S.B.).

ACKNOWLEDGEMENTS

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S.K. TALUKDAR
D.P. SANYAL
B. DUTTAGUPTA

January 25, 1989.

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## 40. ON A SMALL COLLECTION OF FISH FROM MIZORAM, INDIA

The state of Mizoram is surrounded by Assam to the north, Manipur and Burma to the east and south, Tripura and Bangladesh to the west, whose fish fauna is fairly well known. This note is based on the fish collected during the faunistic survey of the Teirei river and its tributaries undertaken by the Zoological Survey of India, Calcutta, under the leadership of Dr Shyamrup Biswas, Zoologist, in February–March 1984. A total of 17 species comprising 73 examples belonging to 14 genera, 8 families and 5 orders have been recorded.

The taxonomic account is arranged on the lines adopted in Jayaram (1981). The distribution of the species is given by Jayaram (loc. cit). Lengths of the species given in the note are standard lengths.

### TAXONOMIC ACCOUNT

| | |
|---|---|
| Order | CYPRINIFORMES |
| Family | CYPRINIDAE |
| Genus | *Esomus* Swainson |

**Esomus danricus** (Hamilton)

*Cyprinus danrica* Hamilton, 1822.*Fish. Ganges*: 325, 390; pl. 16, fig. 88 (type–locality: ponds and ditches of Bengal).

*Nuria danrica* Day 1889, *Fauna Br. India, Fish. 1:* 334.

*Material:*
(i) 2 exs., 35 mm, 46 mm; 26 February 1984.
(ii) 3 exs., 42 mm, 48 mm; 27 February 1984.

This larvicidal fish is provided with a lateral line which pierces only 4-6 anterior scales. This fish is popularly called "Flying Barb". It is also known from Malaya and Thailand.

Genus *Danio* Hamilton

**Danio (Danio) aequipinnatus** (McClelland)

*Perilampus aequipinnatus* McClelland, 1839, Asiat. Res. 19(2): 393, pl. 60, fig. 1 (type—locality : Assam)

*Danio (Danio) aequipinnatus* Hora & Mukerji, 1934, Rec. Indian Mus. 36(1): 133 (synoptic table to species of the subgenus Danio).

*Material:* 3 exs., 48 mm to 60 mm; 27 February 1984.

Hora & Mukerji (1934) gave a synopsis not only of the Indian and Burmese species of *Danio* then known, but also of *Brachydanio*. In this synopsis *Danio aequipinnatus* (McClelland), *Danio strigillifer* Myers and *D. malabaricus* Jerdon are shown as three distinct species. Hora & Nair (1941) synonymised *D. strigillifer* and *D. malabaricus* with *D. aequipinnatus*. Mukerji (1934) again synonymised *D. browni* Regan with *D. aequipinnatus*.

This species has a preorbital spinous process directed backwards at the anterior rim of the orbit derived from the lachrymal bone.

### Danio (Brachydanio) rerio (Hamilton)

*Cyprinus rerio* Hamilton, 1822, *Fish. Ganges:* 323, 390 (type—locality : R. Kosi).

*Danio (Brachydanio) rerio,* Hora & Mukerji, 1934, Rec. Indian Mus. 36(1) : 130, 131 (synoptic table to species of the subgenus Brachydanio).

*Material:*

9 exs., 21 mm to 23 mm; 27 February 1984.

This species in this area entirely lacks the lateral line and shows a tendency towards the reduction in number of anal fin rays 12–15 *v.* the normal 15–16.

### Genus *Rasbora* Bleeker

### Rasbora daniconius daniconius (Hamilton)

*Cyprinus daniconius* Hamilton, 1822, *Fish. Ganges:* 327, pl. 15, fig. 89 (type–locality : rivers of southern Bengal) *Rasbora daniconius* Day, 1878, *Fish. India:* 584, pl. 146, fig. 2.

*Material:*

(i) 13 exs., 28 mm to 74 mm; 26 February 1984.

(ii) 5 exs., 43 mm to 65 mm; 27 February 1984.

Seven out of the 18 specimens of this species have an incomplete lateral line extending either up to the base of anal fin or between it and base of the caudal fin. The specimens also show a marked increase in the number of dorsal and anal fin rays. Dorsal fin rays 10 (ii, 8) v. the normal 9 (ii, 7) and anal fin rays vary from 8 to 9 (ii–iii, 6) *v.* the normal 7 (ii, 5).

### Genus *Amblypharyngodon* Bleeker

### Amblypharyngodon mola (Hamilton)

*Cyprinus mola* Hamilton, 1822, *Fish. Ganges:* 334, 392, pl. 38, fig. 92 (type—locality : ponds and freshwater rivers in every part of the Gangetic provinces).

*Amblypharyngodon mola* Day, 1889, *Fauna Br. India, Fish 1:* 291, fig. 101.

*Material:* 3 exs., 41 mm to 49 mm; 26 February 1984.

Lateral lines of these specimens pierce upto 14-15 anterior scales. Anal fins show a marked increase in the number of rays 9- 10 (iii, 6–7) v normal 7 (ii, 5) and dorsal fin rays 9–10 (ii, 7–8) v. the normal 9 (ii, 7).

### Genus *Barilius* Hamilton

### Barilius barila (Hamilton)

*Cyprinus barila* Hamilton, 1822, *Fish. Ganges:* 267, 384 (type—locality : rivers of northern Bengal)

*Barilius barila* Day, 1878, *Fish. India:* 594, pl. 149, fig. 4.

*Material:*

2 exs., 91 mm, 105 mm; 27 February 1984.

Day (1878) described this species as having only one pair of rostral barbels. It has two pairs of barbels — a rostral pair equal to half of eye diameter and a maxillary pair shorter than the rostral pair. Hora (1921) has already recorded this species with two pairs of barbels from Manipur.

### Genus *Puntius* Hamilton

### Puntius chola (Hamilton)

*Cyprinus chola* Hamilton, 1822, *Fish. Ganges:* 312, 389 (type—locality: northeastern parts of Bengal).

*Barbus chola* Day, 1878, *Fish. India:* 571, pl. 142, fig. 4.

*Material:*

3 exs., 43 mm to 57 mm; 26 February 1984.

Chaudhury (1911) recorded this species from Yunnan Province, China. Generally a dark blotch is present between the 21st and 23rd scales on the lateral line besides a dark mark at the base of anterior dorsal fin ray.

### Puntius sophore (Hamilton)

*Cyprinus sophore* Hamilton, 1822, *Fish. Ganges:* 310, 389 (type–locality: ponds of Bengal)

*Barbus stigma* Day, 1878, *Fish. India:* 579, pl. 141, fig. 5.

*Material:*

1 ex., 19 mm; 26 February 1984.

Chaudhury (1916) clarified the errors in Hamilton's original description of this species in respect of the barbels and also the erroneous identification of Day (1878) of material not referable to this species at all. *P. sophore* is without barbels and is a common species throughout India. there is no justification for retaining *P. stigma* without barbels as a separate species. As the name *sophore* has priority over *stigma* the latter is synonymised

The specimen has a dark blotch, more or less distinct at the base of the caudal fin.

### Puntius ticto ticto (Hamilton)

*Cyprinus ticto* Hamilton, 1822, *Fish. Ganges:* 314, 389, pl. 8, fig. 87 (Type-locality: southern parts of Bengal) Barbus ticto Day, 1889, *Fauna Br. India, Fish 1:* 325.

*Material:*

1 ex., 40 mm; 26 February 1984.

The specimen has an incomplete lateral line which is perforated only up to the 7th anterior scale. A dark spot is present on the third and fourth scales and a second dark spot above the lateral line over the 18—20 scales.

| | |
|---|---|
| Family | COBITIDAE |
| Genus | *Botia* Gray |

### Botia (Botia) dario (Hamilton)

*Cobitis dario* Hamilton, 1822, *Fish. Ganges:* 354, 394, pl. 29, fig. 95 (type—locality : northern rivers of Bengal).

*Botia dario* Day, 1878, *Fish. India:* 606, pl. 154, fig. 1.

*Material:*

1 ex., 52 mm; 1 March 1984.

Hamilton (1822) described this species along with *Botia geto* from north Bengal. Gunther (1868 : 366) regarded *B. geto* as a young form of *B. dario*. Hora (1932 : 573) considered *B. geto* as a juvenile form of *B. dario*. Comparison of a large series of specimens of the two species show that the different colour pattern of the two species is very closely related with each other and hence has no specific value. It is relevant to mention here that *B. geto* of Day's later works (1878, 1889) is a different species and was described by Hora (1932) as *Botia dayi*.

The single specimen of this species in this collection has seven vertical broad bands.

Genus *Lepidocephalus* Bleeker

### Lerpidocephalus (Lepidocephalichthys) guntea (Hamilton)

*Cobitis guntea* Hamilton, 1822, *Fish. Ganges*: 353, 394 (type—locality: ponds and freshwater rivers of Bengal)

*Lepidocephalichthys guntea* Day, 1878, Fish. India: 609, pl. 155, fig. 4

*Material:*

(i) 11 exs., 41 mm to 54 mm; 26 February 1984

(ii) 1 ex., 52 mm; 27 February 1984

| | |
|---|---|
| Order | SILURIFORMES |
| Family | BAGRIDAE |
| Genus | *Mystus* Scopoli |

### Mystus bleekeri (Day)

*Bagrus keletius (nec.* Valenciennes) Bleeker, 1846, *Nat. Geneesk Arch. Ned. Ind* (2) 3: 135 (type—locality : Bengal)

*Mystus bleekeri* Day, 1878, *Fish. India:* 451, pl. 101, fig. 1 (new name for *Bagrus keletius* Bleeker)

*Material:*

1 ex., 97 mm; 26 February 1984

| | |
|---|---|
| Family | HETEROPNEUSTIDAE |
| Genus | *Heteropneustes* Muller |

### Heteropneustes fossilis (Bloch)

*Silurus fossilis* Bloch, 1794, *Naturg. Ausland. Fische 8:* 46, pl. 370, fig. 2 (type—locality : Tranquebar)

*Saccobranchus fossilis* Day, 1889, *Fauna Br. India, Fish 1:* 125, fig. 53.

*Material:*

(i) 1 ex., 110 mm; 26 February 1984.

(ii) 1 ex., 127 mm; 27 February 1984.

| | |
|---|---|
| Order | ATHERINIFORMES |
| Family | CYPRINODONTIDAE |
| Genus | *Aplocheilus* McClelland |

### Aplocheilus panchax (Hamilton)

*Esox panchax* Hamilton, 1822, *Fish. Ganges:* 211, 380, p. 3, fig. 69 (type—locality : ditches and ponds of Bengal)

*Haplocheilus panchax* Day, 1878, *Fish. India:* 523, pl. 121, fig. 3.

*Material:*

2 exs., 33 mm, 37 mm; 26 February 1984.

It is a widely distributed species of the Oriental region.

| | |
|---|---|
| Order | CHANNIFORMES |
| Family | CHANNIDAE |
| Genus | *Channa* Scopoli |

### Channa punctatus (Bloch)

*Ophicephalus punctatus* Bloch, 1793, *Naturg. Ausland. Fische 7:* 139, pl. 358 (type—locality : Malabar coast)

*Ophiocephalus punctatus* Day, 1878, *Fish India:* 367, pl. 78, fig. 1.

*Material:*

3 exs., 95 mm to 110 mm; 27 February 1984.

| | |
|---|---|
| Order | PERCIFORMES |
| Family | NANDIDAE |
| Genus | *Badis* Bleeker |

### Badis badis (Hamilton)

*Lambrus badis* Hamilton, 1822, *Fish. Ganges:* 70, 368, pl.

28, fig. 23 (type—locality: ponds and ditches throughout the Gangetic provinces)

*Badis buchanani* Day, 1878, *Fish. India:* 128, pl. 31, fig. 6.

*Material:*

(i) 2 exs., 37 mm, 38 mm; 26 February 1984.

(ii) 1 ex., 50 mm; 1 March 1984.

Family GOBIIDAE
Genus *Glossogobius* Gill

### Glossogobius giuris giuris (Hamilton)

*Gobius giuris* Hamilton, 1822, *Fish. Ganges:* 51, 366, pl. 33, fig. 15 (type—locality : ponds and freshwater rivers of Gangetic Provinces)

*Gobius giuris* Day, 1878, *Fish. India:* 294, pl. 66, fig. 1.

*Material:*

3 exs., 60 mm, 74 mm; 26 February 1984.

It is one of the most widely distributed species of the Oriental region.

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August 17, 1984 R.P. BARMAN

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## 41. A NEW DISTRIBUTIONAL RECORD FOR *ISO NATALENSIS* (REGAN, 1919) (PISCES: ISONIDAE) FROM THE BAY OF BENGAL

During a study of rock–pool fishes at Visakhapatnam on the east coast of India, we collected the fish *Iso natalensis*, which has so far been recorded only from the south—east coast of Africa. The fish conforms to the description and figure given by Smith (1961: 324). The fishes of this family are commonly called silver–sides.

*Material examined*: 49 (22.5–42 mm SL)

(a) 1 sp., 35 mm SL: 16 Nov 1978

(b) 6 sp., 22.5–29.5 mm SL: 30 Nov 1978

(c) 21 sp., 29.5–37 mm SL: 28 June 1979

(d) 21 sp., 31.5–42 mm SL: 10 July 1979

*Description:* D. III–VI; I 12–16; P 12–14; V I 5; AI 21–28; C 15; gill rakers 3–4 + 1–10–12 (1 ray on each arm sometimes rudimentary), lateral series of scales 45–50; L.tr. 5/1/6–7.

*As percentage of standard length:* Total legnth 115.3–127.9; body depth 22.0–28.6; head length 19.6–25.0; snout length 5.4–9.5; eye diameter 7.1–10.0; interorbital 7.9–10.9; pectoral length 13.5–18.8; ventral length 8.0–11.7; distance to first dorsal 44.3°.0; to second dorsal 63.3–71.9; pre–pectoral distance 23.0–28.6; pre–ventral distance 33.3–39.6; pre–anal distance 52.4–60.0.

*As percentage of head length:* Snout 25.0–37.5; eye diameter 30.0–42.9; inter–orbital distance 35.3–48.0; post–orbital 31.3–43.8.

Body elongate, compressed, deepest at pectoral origin. Mouth small, slightly oblique, villiform teeth in both jaws and on vomers and palatines; outer single row of teeth in both jaws elongated and curved. Teeth on upper jaw are visible even when the mouth is closed. Maxillary reaching below anterior margin of pupil. Pre–opercular margins and angle finely serrated, opercle smooth, post–opercular margins and angle finely serrated, opercle smooth, post–orbital less than half in head length; spines of fins weak. Second spine of the first dorsal longest; second dorsal rays longer than spines. Pectoral high up, reaching middle of ventral. Ventrals short. Ventralmost row of scales between ventral and anal fins larger than those immediately above them and the three scales of either side between vent and anal fin are fused. Anal spine shorter than rays. Caudal forked, lobes rounded. A minute, cartilaginous protruberance beyond vent. Scales ctenoid, thin and highly deciduous. Head, belly upto vent naked. Pre–dorsal scales present.

*Colour:* A broad silvery band along the body from pectoral base to slightly beyond middle of caudal peduncle, with a silvery blotch at base of caudal fin. The band is bordered above by a narrow grey–green stripe with iridescence. Above and below the band, the body is translucent in life, becoming opaque after death. On dorsal side

TABLE 1

DIFFERENCES BETWEEN *Iso natalensis* AND *I. flosindicus*

| S.No. | Character | *Iso flosindicus* Herre, 1944, | *Iso natalensis* Smith, 1965 | *Iso natalensis*, material observed 1979 |
|---|---|---|---|---|
| 1. | Teeth on vomer | Not seen? | Few each side | Patch of teeth on each side |
| 2. | Teeth outside closed mouth | Yes | Upper front | On upper jaw |
| 3. | Dorsals | III-IV - I 13-15 | IV-VI - I 13-17 | III-VI - I 12—16 |
| 4. | Anal | I21—24 | I 21—27 | I 21—28 |
| 5. | Pectoral | ? | 12—13 | 12—14 |
| 6. | Number of lateral series of scales | 40–44 | About 60 | 45-52 |
| 7. | Gill rakers | 3 + 10 | 3-4+1+10+12 | 3-4+1+10-12 |
| 8. | Body depth in standard length | 3.3–3.53 | 3.6-4.6 | 3.09-4.21 |

of head there is a violet blotch. From between the middle of the eyes in the anterior half is an unpigmented spot which later becomes conspicuous after preservation. Dorsal surface of snout dusky. Maxilla, cheeks and ventral side of head silvery. Fins hyaline.

### Discussion

The present specimens conform to the description given by Smith (1965) for *Iso natalensis* in all respects except for minor differences in the dorsal fin formula and the number of lateral series of scales. Smith (op. cit.) gave the number of first dorsal spines as IV–VI. In the present specimens the number ranges from III–VI. The lateral series of scales are found to be less in number (42–52) as against 60 given by Smith. The presence of a smaller number of scales may be correlated to the smaller size of the specimens as observed by Smith.

*Iso flosindicus* Herre, 1944 has been recorded earlier from Visakhapatnam. But the present specimens differ from the above species in the number of dorsal spines, gill rakers, anal fin rays and lateral series of scales (Table 1).

This fish is being recorded for the first time from India from a rock—pool at Visakhapatnam on the east coast. The authentic record so far is only from South Africa (Smith 1961). According to Smith (1961) related species recorded from Japan and Australia held to be distinct may all eventually be found to be the same (species) (p. 324). As Herre (1944) erected the species *Iso flosindicus* on the basis of a single specimen, which was much spoiled, its validity is doubtful. However, the type should be compared before the name is synonymised.

N.A.V. PRASAD REDDY
April 19, 1989 C. UMA DEVI

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## 42. KEY TO GENERA AND RECORDS OF SOME SPECIES OF COCCINAE (HOMOPTERA : COCCIDAE) FROM INDIA

### Subfamily COCCINAE Falien

Recently, Varshney (1985) listed 25 genera of Coccidae from India under 3 subfamilies : Filippiinae, Coccinae and Ceroplastinae. In the present study only 2 subfamilies are recognized except Filippiinae, the genera of which are considered here in Coccinae. The Indian genera and species of Ceroplastinae are included by Avasthi & Shafee (1986). Therefore only the subfamily Coccinae is treated here which is represented by 23 genera from India. So far, no consolidated key for the identification of Indian genera is available. The main object of this paper is to present a key to the Indian genera of Coccinae.

Observations if any, and records of 6 species of Coccinae are also given. The genus *Chloropulyinaria* Borchsenius is not considered here as distinct from *Pulvinaria* Targ.—Tozzt. as we did not find any remarkable difference between these two genera. The material studied by us are deposited in the Zoological Museum, Aligarh Muslim University, Aligarh, India.

### KEY TO INDIAN GENERA OF COCCINAE, BASED ON ADULT FEMALES

1. Marginal setae variously shaped, but never broadly expanded and flattened ....................................... 2

— Marginal setae broadly expanded and flattened ....................................... *Paralecanium* Cockerell

2. Cribiform plates or rounded chitinous areas present on dorsum ....................................................3

— Cribiform plates absent on dorsum ..................... 5

3. Legs and antennae absent or much reduced; with more than 4 cribiform plates of variable sizes ..................................................... 4

— Legs and antennae well developed; with only 4 quite large cribiform plates, all of about the same size .............................. *Hemilecanium* Newstead.

4. Legs and antennae rudimentary; derm around anal plates unsclerotized....*Cribrolecanium* Green

— Legs and antennae absent; derm around anal plates strongly sclerotized................ *Akermes* Cockerell

5. 8–shaped pores absent on dorsum, if present sparse in distribution.......................................... 6

— Large 8–shaped pores present along the mid—dorsal line and around body margin .......................................*Cardiococcus* Cockerell

6. Legs and antennae well developed; multilocular pores mainly confined to abdominal venter; spiracles not surrounded by sclerotic plate...........7

— Legs and antennae much reduced or rudimentary; numerous multilocular pores present along the sides of body;
spiracles surrounded by a sclerotic plate .......................... *Lecanopsis* Targioni—Tozzetti

7. Longitudinal series of conical spines absent on dorsum. ..........................................................8

— 2 longitudinal series of short, thick conical spines extend from rostrum to abdomen on dorsum ..................................*Metaceronema* Takahashi.

8. Ventral tubular ducts numerous...........................9

— Ventral tubular ducts absent or very few in number .......................................................................21

9. Stigmatic spines if present 1–6 only..................10

— Stigmatic spines numerous, stout, bluntly rounded, in the usual 4 groups, each accompanied by sclerotic plate .........................*Ceronema* Maskell.

10. Stigmatic spines more or less resemble with marginal spines or somewhat represented by 1–2 slightly longer setae. .........................................11

— Stigmatic spines 3, rarely 5–6, much distinct from marginal setae ...................................................15

11. Tubular ducts either absent on dorsum or very infrequent, if numerous, sparsely distributed .....12

— Tubular ducts very frequent on dorsum, arranged in mid–longitudinal and marginal band ..............................*Dicyphococcus.* Borchsenius

12. Marginal setae conical or slendrical ................. 13

— Marginal setae spear—head shaped .......................................*Ceroplastodes* Cockerell

13. Submarginal band of tubular ducts absent on venter ..........................................................................14

— Submarginal band of tubular ducts present on venter. ...............................*Eulecanium* Cockerell

14. Distinct mid—dorsal line of pores present; multilocular pores confined to anal region and on the abdomen; glossy test is divided longitudinally into two halves............................*Inglisia* Maskell.

15. Mid-dorsal line of pores absent; multilocular pores present throughout the median region of thorax and abdomen; glossy test notdivided longitudinally into two halves .......................... *Ctenochiton* Maskell

15. Anal cleft normal not extending to centre of body; anal plates variable ...........................................16

— Anal cleft long extending to centre of body; anal plates elongate, about 4 times longer than wide ..................................*Protopulvinaria* Cockerell

16. Submarginal band of tubular ducts present on venter ..........................................................................17

— Submarginal band of tubular ducts absent on venter ..........................................................................19

17. Multilocular pores confined only to the abdominal venter; median stigmatic spine much longer than laterals...........................................................18

— Multilocular pores present ventrally on abdomen and also present in groups behind base of each coxae..............................*Parthenolecanium* Sulc.

18. Dorsal setae cylindrical or slightly swollen apically; anal plates without large discal seta; dorsum with cellular pattern composed of distinct polygonal areas...............................*Parasaissetia* Takahashi

— Dorsal setae setose or spinose; anal plates with a large discal seta; dorsum with cellular pattern composed of much less distinct circular or oval areas.................................. *Saissetia* Deplanche

19. Marginal setae of variable shapes, simple, bifid, fimbriate or clubbed apically; stigmatic clefts usually with 3 spines, anal plates with thin apical setae ............................................................ 20

— Marginal setae thick, stout, more or less cylindrical, mostly with bidentate apices; stigmatic clefts each with 4-5 spines of variable lengths; anal plates with a thick apical setae...*Megapulvinaria* Young.

20. Ovisac is not strongly convex (Borchsenius, 1957) ........................... *Eupulvinaria* Borchsenius

— Ovisac strongly convex (Borchsenius, 1957) .................... *Pulvinaria* Targioni—Tozzetti

21. Stigmatic spines 3, median longer than laterals, located in the centre of the clefts; paraopercular pores if present few, never extend upto head .....22

— Stigmatic spines 2 of equal sizes on either end of the sclerotized band; paraopercular pores numerous, arranged in a band along the median line of the body and extending as far as the head ..................... *Marsipococcus* Cockerell & Bueker

22. Dorsum with large tessellation ....................................... *Eucalymnatus* Cockerell

— Dorsum without tessellation....... *Coccus* Linnaeus

### **Ceroplastodes cajani** (Maskell)

*Material examined*: 16 females, INDIA: Uttar Pradesh, Aligarh, on *Ficus infectoria* 10. viii. 1980 (*R.K. Avasthi).*

This species is more common on *Ficus* plants at Aligarh. It is easily recognized in the field by the presence of glossy covering whereas the mounted specimens by the presence of single large spine on dorsum at the region of stimatic clefts and two rows of small spear—head shaped marginal spines.

### **Megapulvinaria maxima** (Green)

*Material examined:* 2 females INDIA: Andhra Pradesh, Nellore, Bucchireddypalam, on weed plant, 27. i. 1978; 1 female, Tamil Nadu, Coimbatore, on *Flacourtia indica*, 27. iii 1979 (*R.K. Avasthi*).

This species is considered as a serious pest of Neem trees in India (Ayyar 1930). Mounted specimens are easily identified by the stout, truncated marginal spines with bidentate apices.

### **Parasaissetia nigra** (Nietner)

*Material examined*: 8 females INDIA: Tamil Nadu, Coimbatore, on *Hibiscusrosa-sinensis* L., and *Abutilon indicum*, 27. iii. 1979 (*R.K. Avasthi*).

Mounted specimens of this species are easily identified by the presence of large pale polygonal areas and thick, cylindrical setae with slightly swollen apices on dorsum.

### **Saissetia coffeae** (Walker)

*Material examined:* 3 females, India: Andhra Pradesh, Guntur, on *Cajanus cajan*, 5. i 1967; 5 females, Tamil Nadu, Tirunlveli, on *Psidium guava* L., 5. iii. 1967 (*S.A. Shafee*). 2 females, Coimbatore, Mettupalaiyam, on weed plant, 27. iii 1979 (*R.K. Avasthi*).

### **Saissetia oleae** (Olivier)

*Material examined*: 4 females, INDIA: Andhra Pradesh, Guntur, Ponnur, on *Cajanus cajan*, 3. iv. 1979 (*R.K. Avasthi*).

De Lotto (1971) discussed the authorship of this species and credited it to Olivier instead of Bernard.

### **Saissetia privigna** De Lotto

*Material examined*: 5 females, INDIA: Andhra Pradesh, Guntur, on *Abelmoschus esculentus* 14, iv. 1979 (*R.K. Avasthi*).

This species is closer to *S. oleae*, but distinctly differs in having numerous long marginal setae and in the shape of tubular ducts which have inner ductule much narrower than outer.

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RAJENDRA KUMAR AVASTHI
August 18, 1988. S. ADAM SHAFEE

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## 43. A NEW TYPE OF MIMICRY IN BUTTERFLIES

Hitherto, two types of inter–butterfly mimicry have been observed:

1. Batesian, where non–poisonous/ palatable butterflies, generally females, mimic wing coloration patterns, habits and flight patterns of poisonous/ non palatable butterflies. Batesian mimicry is apparent in relationships such as those between females of the Eggfly *Hypolimnas misippus* L., the Palmfly *Elymnias hypermnestra* L. on the one hand and the Plain Tiger *Anosia chrysippus* L. on the other. Similarly between the Tawny Mime *Chilasa agestor* Mo. and the Chestnut Tiger *Parantica sita* Kol.
2. Mullerian, where poisonous butterflies mimic each other's wing/body coloration in an effort to develop a warning coloration pattern easily recognisable by predators. Mullerian mimicry is prevalent among the Windmills (*Byasa dasarada* M. group), the Black Crows (*Euploea core* Cr. group)and the Blue Crows (*Euploea mulciber* Cr. group).

A strange relationship exists between the Swordtails (*Pazala eurous cashmirensis* Roth. and *Pazala glycerion* Gr.) and the Cabbage Whites (*Pieris brassicae* L. and *Artogeia canidia* Sparrman).

The Swordtails are on the wing for two to three weeks in early spring, at elevations between 1250–2200 m above sea level. Their flying time coincides with the first brood of Cabbage whites. During this period, the Whites outnumber the Swordtails in a ratio of about 25:1.

During the morning hours, the Swordtails make no attempt to mimic any insect, but depend on swift flight in the upper canopy of trees to avoid predators. At midday, however, both species of Swordtails come down to 3–5 m above ground level, that is, the zone in which Cabbage Whites are predominant. At this level, they affect the much slower, fluttering, erratic flight of the Whites as opposed to their normal 'flap and glide' technique making it extremely difficult to distinguish between the mimic and the model. The reason behind this became clear when I (in the role of predator) tried to catch them. Calculating the net's sweep according to the feigned flight of the Swordtail, I was surprised when it reacted with a series of high speed, complicated manouvres that on most occasions left me baffled.

Since these insects seem to be capable of reacting more swiftly than Cabbage Whites and are more alert, they generally manage to escape into the upper canopy (birds seem to be incapable of maintaining the rate of acceleration while ascending) when attacked, and, after a while, return to the lower levels to continue the mimicry. The other advantage of this form of mimicry lies in the large population of the models. The chances of being singled out for attack are considerably reduced by 'merging with the crowd'. In the case of the Swordtails, this fact is relevant since they are the only inhabitants of the upper canopy at that time of the year.

I propose to refer to this form of mimicry as Self–Detractive mimicry because the mimic actually imitates the vulnerability of the model and, after detracting from its own abilities, depends upon its true capabilities to escape predators. As opposed to this is Batesian mimicry, where the non–poisonous mimic imitates various aspects of the poisonous model in order to be considered poisonous as well. Since it is *being poisonous* that makes the model invulnerable, it is clear that the mimic imitates this invulnerable aspect of its model.

Self–detractive mimicry is also prevalent between the Sailers (Genus *Neptis*), which are the models and the Sergeant Major *Abrota ganga* Mo., the Sergeant Emperor *Apatura chevana* Mo. and the Sergeants (Genus *Athyma*, prev. *Pantoporia*) which are the mimics. It probably exists in other insect relationships, but results can only be obtained by observation of the subjects in their natural habitat.

August 3, 1988

PETER SMETACEK

## 44. OVIPOSITION BEHAVIOUR AND EGG HATCHABILITY IN TASAR UJI FLY *BLEPHARIPA ZEBINA* (WALKER)

*(With a text-figure)*

### Introduction

The tasar uji fly *Blepharipa zebina* (Walker) (Diptera: Tachinidae) has been a major parasitoid of tasar silkworm *Antheraea paphia* (Linn.) (=*A. mylitta* Drury) in the traditional and oak tasar belts of North India, causing nearly 10% loss to the tasar crop (Jolly *et al.* 1974). The parasitoid occurs in Khanapur and Biligiri Rangana Hills of Karnatak where tasar silkworm is reared on commercial scale. A perusal of literature revealed that information on oviposition behaviour and egg hatchability of the parasitoid is very scanty, and this paper deals with the above aspects.

### Material and Methods

The observations on oviposition behaviour were made at the Basic Tasar Seed Farm, Khanapur (Belgaum District) during December, 1986. The *A. paphia* worms utilized for the study were from the commercial outdoor rearings on *Terminalia* trees. They were mostly at their III or IV instars. The uji infested worms were brought and held in the laboratory for studies on oviposition and egg hatchability of the parasitoid.

### Observations and Discussion

**Host–stage–preference:** The uji fly exercised care and preference in selecting the proper host for oviposition. Fourth instar worms were most preferred as compared with those at III instar. In the present survey, the number of eggs laid by the parasitoid on IV instar host was ten times the number laid on III instar host. For instance. on an average 41.33 eggs (ranging from 22 to 77 per larva) were laid on IV instar, whereas only 4.0 eggs (ranging from 1 to 8 eggs per larva) were laid on III instar tasar worm. Even during the III moult, i.e. at the time when the host was entering into its IV instar, the number of eggs laid by the parasitoid was very less (average 1.67). Moreover, the worms at II and I instars were among the least preferred ones. Interestingly, no eggs were laid on the fully grown prespinning or spinning worms. Likewise, the worms settling for moult were also avoided. Besides, less number of eggs (on an average 2.0 per larva) were laid on pebrinised worms. Furthermore, it was noticed that, even among the worms of preferred instars, the fly selected well–fed worms as against the poorly developed ones. Singh (1986) remarked that generally the parasitoid preferred bigger worms. However, the present study shows that the preferences were made on the basis of the host–stage, health and vigour.

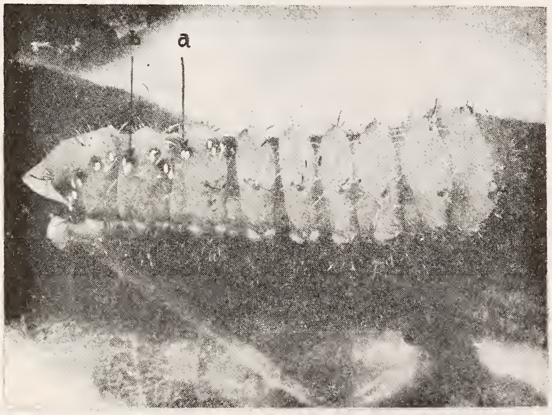

Fig. 1. Tasar silkworm *Antheraea paphia* parasitized by uji fly *Blepharipa zebina:* a. Tasar uji fly eggs; b. Black scar, diagnostic of tasar infestation.

**Host–site–preference:** The parasitoid laid the majority of eggs on the dorsal surface of the host. For example, about 75.4% of the eggs were laid on dorsal aspect, while only 24.1 and 0.5% on the lateral and ventral surfaces respectively. Reasons for such a preferential deposition of the eggs appear to be the responses of the host to the uji fly at the time of oviposition. It was observed that the fly which alighted on the lateral aspect was driven away by the sideward movements of the body, and the eggs laid on sides were dislodged by nibbling by the host. Moreover the parasitoid could hardly get any space to oviposit on the ventral surface since it was tightly attached to the substratum. However, the fly which alighted on dorsal surface remained undisturbed.

**Act of oviposition:** The adult uji flies were very active during cooler hours of the day with moderate sunshine, i.e. from 0900 to 1200 hrs and 1600 to 1700 hrs. During this period they flew actively around the tasar silkworms.

Initially, tasar silkworms did not allow the gravid female uji fly to alight on their body for oviposition. They briskly moved their anterior portion of the body sidewards so that the fly got physically disturbed. However, the female fly made persistent and hectic attempts to settle on the body of the host. Too frequent visits by the fly ultimately exhausted the worms and at this stage the fly alighted on the host's body and walked freely over its body.

Settling on the host, the fly first feels the surface of the worm with the help of its protruded ovipositor. Sitting parallel to the body segments of the host, she fastened the eggs one after another tranversely to the long axis of the body,avoiding the intersegmental regions and the tubercles. The eggs were laid singly but in instalments. In majority of the cases the eggs were glued side by side very near to each other (Fig. 1) with their micropylor end invariably pointing upwards. At each visit the fly laid one or more than one egg on the host. A maximum of 77 eggs were counted on the body of a healthy IV instar host. Perhaps, therefore, the superparasitism was very common in the tasar population.

**Hatching of eggs:** The eggs usually hatched in 3 days after deposition, i.e., in the present case they hatched in the last week of December. The percent hatchability was as high as 97.9 (ranging from 66.7 to 100) under laboratory conditions. A longitudinal slit was made on the attached surface of the egg extending up to 1/2 or 2/3 length from the micropylar end. And the tiny maggot penetrated directly into the host's integument through the slit. Soon the area around the point of entry of the maggot became black (Fig. 1). This black mark is the characteristic feature of uji fly infestation which can be utilized for diagnostic purpose. The egg shell remained attached to the integument of the host even after the death, decay and drying of the carcass of the silkworm.

G.M. PATIL
January 20, 1989. C.J. SAVANURMATH

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## 45. A CONTRIBUTION TO THE FLORA OF GANGANAGAR (RAJASTHAN)

### INTRODUCTION

Ganganagar is situated in the north of Rajasthan State between 28° 40' and 30° 06' N Lat. and 72° 36' and 75° 30 E Long. It constitutes a part of the Great Indian Desert. The Gang canal drawing water from the Sutlej river was launched in the year 1927–28, which has greatly changed the face of the area. The irrigation waters, which owe their source to the Punjab rivers, have been bringing seeds and other propagules of a number of extra–limital species year after year and many of these have already become successfully established in the area as crop weeds or along the banks of canals (Dhillon and, Bajwa 1969, Dhillon and Bhandari 1974, Singh and Brar 1984). The most striking example of this naturalization of Himalayan plants in the Great Indian Desert are species of *Riccia, Marchantia* and *Ophioglossum vulgatum* L. (Singh and Brar 1980) which are found frequently in the canal irrigated areas, showing thereby the extent to which plants from the Himalayas and other places have become naturalised in the irrigated desert.

There are no rocks or gravelly soil in the district. In the irrigated tract, soil under irrigation by Gang canal and Bhakra canal are sandy–loam. In the non–command areas, sandy plains with stabilized and shifting sand dunes are a common sight in the South of the district and its adjoining districts Churu and Bikaner of Rajasthan. There is a seasonal river called Ghagger which enters the tehsil Tibbi in the East and through Anupgarh flows to Pakistan. The soil in the bed of this river is heavy clay. There are some saline areas near Jetsar and Anupgarh where a few halophytes occur. The average annual rainfall is less than 300 mm. The rainy months are June to september with maximum rainfall in July—August. The summers are extremely hot and winters severely cold. The maximum and minimum average temperatures recorded are 44° C and 5° C, respectively.

We are presently working on the flora of North Rajasthan. While studying the specimens, we found some of these were not reported previously from Rajasthan desert (Blatt. and Hallb. 1918—21; Puri *et al.* 1964, Bor 1960, Bhandari 1978, Sharma and Tiagi 1979), therefore, new extrants to the desert. The specimens have been preserved in the Herbarium, Department of Botany, SGN Khalsa College, Sriganganagar, Rajasthan.

### RESULTS AND DISCUSSION

The vegetation of the area explored can be divided into:

(1) vegetation of loose sand dunes and sandy regions,
(2) vegetation of stablized sand dunes
(3) vegetation of Ghagger Alluvial plains,
(4) weeds of winter season
(5) weeds of rainy seas on,
(6) vegetation along canals,

(7) aquatic plants,

(8) Common parasites are *Cistanche tubulosa, Orobanche aegyptiaca, Striga angustifolia, Cuscuta reflexa, C. capitata* on *Medicago sativa* and on the species of *Tribulus* and *Zaleya.*

Total number of wild species so far collected is 487, belonging to 305 genera covering 82 families. In the present work, flora of an area of about 20,648 sq.km of northwest part of Thar desert, which is now under irrigation by network of canals system, has been studied and compared with that of non–irrigated regions of the area. A comparison of the vegetation of the hitherto unirrigated areas and that of the irrigated regions of the district of Ganganagar shows that irrigation has brought about remarkable changes in the composition of the original flora, both by way of new introduction as well as elimination of many of the original species. In comparison to the natural flora of the Thar desert (unirrigated parts only), the following species are new introductions in the irrigated regions.

1. *Ranunculus cantonenesis* DC.
2. *R. sceleratus* Linn.
3. *Nymphaea stellata* Willd.
4. *Nelumbo nucifera* Gaertn.
5. *Argemone ochroleuca* Sweet
6. *Dilophia salsa* Thoms.
7. *Farsetia jacquemontii* Hook.f.*et* Thoms.
8. *Malcolmia africana* R. Br.
9. *Hypecoum procumbens* Linn.
10. *Oligomeris linifolia* (Vahl) Macbride
11. *Arenaria serpyllifolia* Linn.
12. *Vaccaria pyrimidata* Medik.
13. *Portulaca grandiflora* Hook.
14. *P. pilosa* Linn.
15. *Oxalis latifolia* H.B. & K.
16. *Astragalus subumbellatus* Klotzsch
17. *A. tribuloides* Del.
18. *Lotus corniculatus* Linn.
19. *Medicago minima* Lamk.
20. *M. lupulina* Linn.
21. *Trigonella hamosa* Linn.
22. *T. pubescens* Edgew.
23. *Myriophyllum spathulatum* Blatt.*et* Hallb.
24. *Anethum graveolens* Linn.
25. *Ammi majus* Linn.
26. *Centella asiatica* (Linn.) Urban
27. *Oenanthe javanica* (Bl.) DC.
28. *Psammogeton canescens* (DC.) Vatke
29. *Trachyspermum ammi* (Linn.) Sprangue
30. *Carthamus oxycantha* Beib.
31. *Cirsium wallichii* DC.
32. *Cichorium intybus* Linn.
33. *Cotula anthemoides* Linn.
34. *Lactuca scariola* Linn.
35. *Parthenium hysterophorus* Linn.
36. *Soliva anthemoides* (Juss.) R. Br.
37. *Sphenoclea zeylanica* Gaertn.
38. *Gastrocotyle hispida* (Forsk.) Bunge
39. *Heliotropium currasavicum* Linn.
40. *Cuscuta capitata* Roxb.
41. *Lycium europaeum* Linn.
42. *Antirrhinum orontium* Linn.
43. *Majus pumilus* (Burm.f.) Steenis
44. *Verbascum thapsus* Linn.
45. *Orobanche aegyptiaca* Pers.
46. *Utricularia inflexa* Forsk.
47. *Lantana camara* Linn.
48. *Salvia plebeia* R. Br.
49. *Plantago amplexicaulis* Cav.
50. *Kochia indica* Wt.
51. *Chrozophora oblongifolia* (Del.) A. Juss.
52. *C. prostrata* Dalz.
53. *Euphorbia helioscopia* Linn.
54. *E. parviflora* Linn.
55. *E. serpens* H.B.E.
56. *Pouzolzia pentandra* (Roxb.) Benn.
57. *Polygonum lanigerum* R. Br.
58. *Ficus palmata* Forsk.
59. *Commelina diffusa* Burm.f.
60. *Lemna trisulca* Linn.
61. *Carex fedia* Nees
62. *Cyperus exaltatus* Retz.
63. *Eleocharis dulcis* (Burm.) Henschel
64. *Fimbristylis diphylla* (Retz.) Vahl
65. *F. woodrowii* Clarke
66. *Pycreus polystachyus* Beauv.
67. *Aristida plumosa* Linn.
68. *Catabrosa aquatica* (Linn.) P. Beauv.
69. *Crypsis schoenoides* (Linn.) Lamk.
70. *Dichanthium odoratum* (Lisboa) Jain
71. *Digitaria bicornis* (Lamk.) Roem.
72. *D. stricta* Roth *ex* Roem.
73. *Diplachne fusca* (Linn.) P. Beauv.
74. *Eleusine indica* (Linn.) Gaertn.
75. *Eragrostis nutans* (Retz.) Nees *ex* Steud.
76. *Koeleria argentea* Griseb.
77. *Leptochloa phleoides* (Vill.) Reichb.
78. *Lolium temulentum* Linn.
79. *Leptochloa chinensis* (Linn.) Nees
80. *L. pumila* (Desf.) Bor
83. *P. psilopodium* Trin.
84. *P. repens* Linn.
81. *Panicum austroasiaticum* Ohwi
82. *P. miliaceum* Linn.

85. *Phalaris minor* Retz.
86. *Setaria homonyma* (Steud.) Chiov.
87. *Sporobolus indicus* auct. non (Linn.) R. Br.

Thus, out of 410 naturalized species of the area, 87 are new entrants in comparison to the flora of the unirrigated desert regions. This means that irrigation over the last 60 years or so has apparently changed about 21 per cent of the species of the natural flora. This is too superficial a judgement since the real change is much more and not easily comprehensible. Some of these new extrants are temperate Himalayan plants such as *Cotula anthemoides, Arenaria serpyllifolia, Astragalus subumbellatus, A. tribuloides, Ammi majus, Trachyspermum ammi, Cichorium intybus, Soliva anthemifolia, Verbascum thapsus, Plantago amplexicaulis, Pouzolzia pentandra* etc. Still many of them are abundant in the cooler regions of Punjab. It is therefore obvious that their seeds have been transported by irrigation waters. Further, protracted irrigation has brought about so much amelioration in the climate that it is already supporting luxuriant growth of such arborescent forms of humid tropics such as *Bambusa.* Many other tree species such as *Dalbergia sissoo, Cordia dichotoma, Jacaranda mimosefolia, Kigelia pinnata, Emblica officinalis,* several species of *Ficus, Morus* and *Phoenix* are doing well in the area.

The natural flora has been modified in another way. Many of the common species of the unirrigated desert which originally belong to this area have disappeared obviously due to protracted irrigation, most probably due to losing competition against the new extrants. Though irrigation has effected the water contents and texture of the soil substantially, not all the changes are for the worse and the floristic richness can be attributed to irrigation alone. With the availability of irrigation, large tracts are now under cultivation and wastelands have become scarce. Wild species can grow only as crop weeds which are regularly removed by the farmers from their fields or on the sides of the roads and canals. This reduction in the realm of wild plants has obviously contributed substantially to the reduction in the number of wild species. However, whatever might be the factors responsible for the change of the natural flora, they are all consequent to the introduction of irrigation.

ACKNOWLEDGEMENTS

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B.P. SINGH
January 15, 1989. K.B.S. DHILLON

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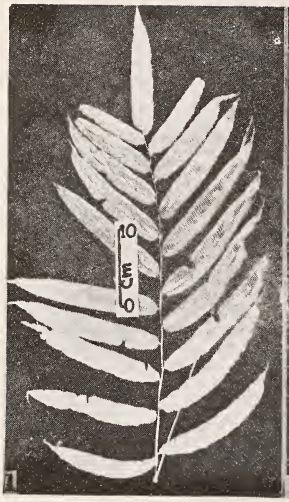
## 46. *PNEUMATOPTERIS NUDATA* (ROXB.) PUNETHA ET KHOLIA COMB. NOV.

*(With eleven text–figures)*

### INTRODUCTION

During our studies on the taxonomy of ferns of Pithoragarh district of Kumaon (N.W. Himalayas), we observed that at least in the fresh specimens of *Pneumatopteris nudata* (*Pronephrium nudatum* (Roxb.) Holtt.) the aerophores at the base of basal pair of pinnae are quite distinct and at least the lowest pair of pinnae is



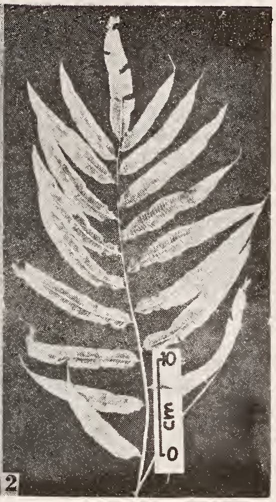


**Fig.** 1. *Pneumatopteris nudata,* habit;

Fig.2. *P. nudata* var. *minor,* isotype.

much reduced, hairs are usually absent on the surface of rhizome scales and rhizome scales are narrower than the rhizome scales of *Pronephrium.* A specimen of this fern with our comments was sent to Prof. R.E. Holttum (Kew), who readily agreed for its transfer to *Pneumatopteris* Some specimens of this fern differ markedly from the typical *P. nudata* in having relatively small fronds, pinnae narrow, base cuneate, apex narrowely acuminate, basal one or two pairs slightly reduced, veins to 15 pairs. When a specimen of this fern was sent to Prof. Holttum, he replied that there are no Kew specimens with such narrowly acuminate pinnae as those found in this fern and he suggested that we describe it as a new variety (var.*minor*) of *P. nudata.*

Nakai (Bot. Mag. Tokyo, 47:179. 1933) erected a new thelypteroid fern genus *Pneumatopteris* to accommodate (*Aspidium callosum* Bl. ferns with free veins, basal pinnae reduced, swollen or normal aerophores present at the base of the lower pinnae. Holttum (1973) redefined the genus and included within it the specimens in which 1. basal pair of pinnae are reduced, 2. aerophores are present at the base of lower pinnae and 3. margins of rhizome scales are hairy (hairs on surface of rhizome scales are usually absent). Although Holttum (1973) gave a detailed taxonomic account of this genus, he described the Roxburgh's fern *Polypodium nudatum* as *Pronephrium nudatum* (1972) and was followed by other workers (Baishya & Rao 1982 Bir *et al.* 1983, Khullar *et al.* 1983. Presence of aerophores at the base of basal pairs of pinnae in this fern was noticed by Beddome (1883, p. 175) but this character was overlooked by subsequent taxonomists.

### Taxonomic Account

**Pneumatopteris nudata** (Roxb.) comb. nov.

*Polypodium nudatum* Roxb., Calc. Journ. Nat. Hist., *4*. 491. 1844.

*Pronephrium nudatum* (Roxb.) Holtt., Blumea, *20:* 111. 1972; Dhir, Bibl. Pterid., *1:* 105. 1979; Dhir, Bibl. Pterid., *2:* 1981; Baishya & Rao, Ferns and Fern—allies of Meghalaya State, 85. 1982; Bir et al, Pteridophytic Flora of Garhwal Himalaya, 38. 1983; Khullar *etal.*.

*Polypodium multilineatum* Wall. ex Hook., Sp. Fil., *5:* 11. 1883.

*Nephrodium moulmeinese* Bedd., Handb. Ferns Brit. India, 275. 1883.

Rhizome wide creeping, scaly at apex; scales lanceolate, margins slightly hairy, surface smooth, apex acuminate; stipe erect, 2–3 cm distant on rhizome, 30–60 cm long, scaly at base, hairy above, scales rhizomatous, hairs acicular, hyaline; lamina ovate, coriaceous, once pinnate, 40–60 x 25–40 cm, pinnae oblong lanceolate, broad, 15-25 x 2.5-4 cm, lowest pair reduced, base broad, apex acute, margins slightly dentate, hairy, hairs on veins, sinus and rachis; swollen aerophores present at the base of pinnae; veins 16–20 pairs, anastomosing and form an excurrent vein to sinus; sori near the excurrent vein or at the junction of veins and excurrent vein, indusiate; indusium reniform, deciduous; sporangia globose, smooth (not setose) with elongated glands; spores brown, ovate perisporiate, finely spinulose, 35 x 28 mm (Figs. 1, 3—5).

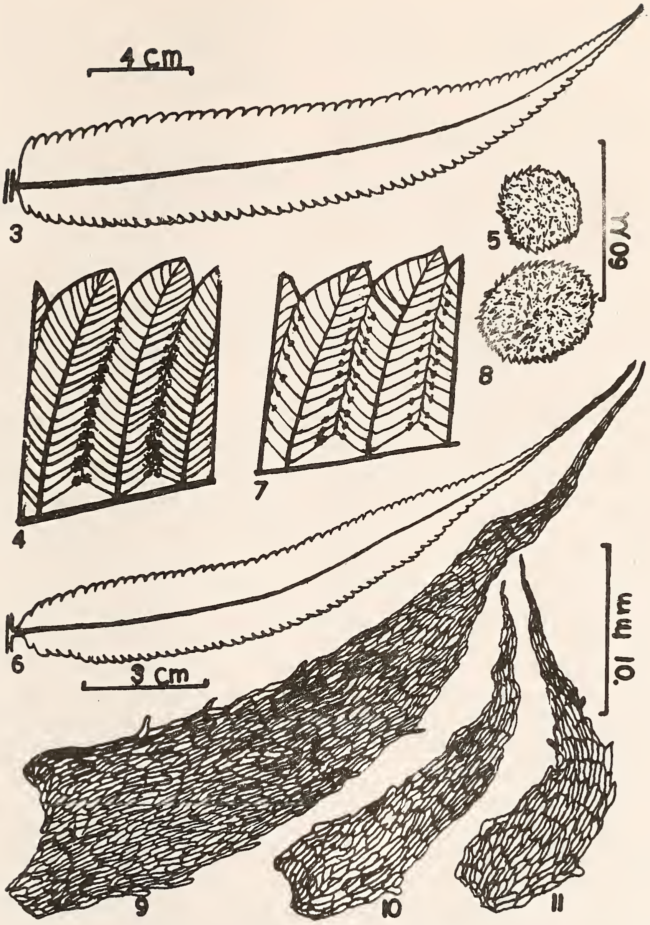
Fairly common throughout the region along hill streams between 600–1200 m.

Mention is to be made of Pangtey *et al.* (1986) regarding its occurrence in Nainital; they believe that they collected this fern for the first time from Nainital. However, as early as 1890, Hope (1904, p. 83) collected this fern (described under the name *Polypodium multilineatum* Wall.) from Gola valley (2500') in Nainital.

*Specimens examined:* K; Bot. Pith. 87211, 87212, 88211, 88212.

*Pneumatopteris nudata* (Roxb.) Punetha et Kholia var. *minor* Punetha et Kholia var. nov.

A varietate typica speciei differt: frondibus minoribus,



Figs. 3-11. 3-5. *P. nudata,* 3. a lateral pinna; 4. venation; 5. spore; 6-11. *P. nudata* var. *minor,* 6. a lateral pinna; 7. venation; 8. spore; 9. rhizome scale; 10. stipe scale; 11. rachis scale.

pinnis angustioribus basi cuneatis et apice acuminatis, pinnis infimis 1—2 jugatis leviter redactis, venis usque 15 jugatis (Figs. 2, 6–11).

A rare fern, only once collected from Hachila village (Didihat 800 m).

*Specimens examined:* K–Holotype; Bot. Pith. 88201—Isotype

### ACKNOWLEDGEMENTS

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N. PUNETHA
B.S. KHOLIA

November 29, 1988.

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## 47. SOME RARE, ENDANGERED AND THREATENED PLANT SPECIES FROM RATNAGIRI DISTRICT, MAHARASHTRA

While going through the Red Data Book of Indian Plants (RDBIP) vol. I, edited by M.P. Nayar and A.R.K. Sastry (1987), we noticed that ten species of flowering plants which have been collected by us from Ratnagiri district are cited in the book.

The present communication is to supplement the data given in the book about these species. These data were collected by us during various field trips in Ratnagiri district. For each plant, the name of the species is followed by the family name, the page number of the species in the RDBIP vol. I and, in quotation marks, the Category used to indicate the degree of threat in the RDBIP. Specimen numbers of our collections are given. All specimens are at Blatter Herbarium, St. Xavier's College, Bombay.

1. **Aponogeton satarensis** Sundara. et al. Aponogetonaceae 41.

"Vulnerable". The species had so far been reported only from the Mavashi plateau in Satara district, Maharashtra. Attempts to find it on the Panchagani plateau were not successful. We have collected the species from the plateau of Gothane village, Sangameshwar taluka, on the crest (alt. 1,000 m) of the Western Ghats. The plants are found only in a small area of the plateau, where a few cms of water accumulates during the monsoon. Live plants continued to flower in Bombay but the tubers did not grow the next year. Since the species is difficult to cultivate, the best conservation measure would be to protect its habitat. The immediate danger to the species at Gothane may be a proposed dam which may inundate the site. Mistry 1006.

2. **Cryptocoryne cognatoides** Blatt. & McC. Araceae 43.

"Vulnerable". The plant has been found once in the same locality as *Aponogeton satarensis* but it grows in marshy soil on edges of ponds and streams. Mistry 1674.

3. **Ceropegia huberi** Ansari Asclepiadacea 58.

"Vulnerable". Collected only from the type locality at the top of Amba Ghat on grassy road embankments which are prone to landslides. Mistry 1266.

4. **Ceropegia oculata** Hook.f. Asclepiadaceae 62.

"Rare". Collected once from the hill—top at Mirya near Ratnagiri, a botanically interesting locality having a reputation for medicinal plants. Mistry 1156.

5. **Ceropegia sahyadrica** Ansari & Kulkarni 69.

"Rare". It is a frequent plant in August—September in the same locality as *Aponogeton satarensis*, but it is more abundant towards the Western edge of the plateau where the soil layer is thicker. Mistry 1191.

All the above species of *Ceropegia* have edible tubers, which nourish both man and animals; this is a major threat to their survival in the wild. Perhaps cultivation is the best conservation measure for the *Ceropegia* species of the District.

6. **Dipcadi concanense** (Dalz.) Baker Liliaceae 175.

"Possibly extinct in the wild; known only from two gatherings; not seen since 1861, though the region has been repeatedly exlored". The species has now been found after 123 years, growing in a fenced, fallow plot of rocky land in Ratnagiri city. The plant is noticeable only when flowering, otherwise it is inconspicuous among grasses. Unless quick measures are taken to protect the samll plot from building activities it is likely to be lost in the near future. Cultivation may be the best conservation measure. Flowers and fruits in August—Mistry 1068.

7. **Iphigenia magnifica** Ansari & Rolla Rao. Liliaceae 183

"Vulnerable". Collected from the borders of rice fields at Phurus on the Khed—Dapoli road and at Mirya near Ratnagiri. Flowers and fruits in August. Mistry 196 & 1155.

8. **Abutilon ranadei** Woodr. & Stapf Malvaceae 198

"Endangered or Presumed Extinct. First described in 1894, next reported in 1901 as a very rare plant; no report since then." This is the first report in 85 years. A single plant was found on forested slopes at the type locality —

Amba Ghat. The species is in great danger of extinction, as is the case of *Ceropegia huberi* in the same area. The habitat is on the verge of destruction, being on the major highway between the cities of Kolhapur and Ratnagiri, with the forest unprotected. Almeida 1375.

9. **Bhidea burnsiana** BorPoaceae–290

"Rare". This species is by no means rare in the district if one has an eye for grasses. M.R. Almeida has collected the species daily on several consecutive field—days from Ratnagiri city and its surroundings. It grows on bare laterite flats, along with a less common and probably more threatened associate *Danthonidium gammiei* (Bhide) C.E. Hubbard. In Ratnagiri district, at least, the species is not in immediate danger — it has survived the expansion of the city and was even found growing near the Police Station in the heart of the city.

It may be pointed out here that another, rarer species of *Bhidea* exists (unless it has become extinct in the last 45 years) in India, undescribed since 1941 when Bor noticed it with *Danthonidium gammiei* (Bhide) C.E. Hubbard specimens sent to Kew from Karnataka by C. McCann, (see Kew Bull. 1948:44. 1949).

Almeida 448, 698A, 914; Mistry 466B.

10. **Dimeria woodrowii** Stapf Poaceae298.

"Rare". An occasional species on bare laterite flats especially near the sea as at Mirya, Mirjole and Shirgaon near Ratnagiri city. Like *Bhidea brunsiana* the species is not in immediate danger since it survives on land which is already so degraded that nothing except short grasses and herbs can grow on it Almeida 470A, 588B & 916.

We wish to thank the following for help given in preparing this paper:

Mr M.R. Almedia of Alchemie Research Centre, Thane for providing some specimens and helping in field work and identification. Dr N.P. Singh and Ms. U.R. Deshpande of BSI, Pune for providing literature and assistance at BSI.

M.K. MISTRY
S.M. ALMEDIA

December 9, 1988.

## 48. *CYRTOMIUM HOOKERIANUM* (PRESL) C. CHR. (ASPIDIACEAE) — A NEW RECORD FOR WESTERN HIMALAYAS

During an extensive plant collection in Kumaun region of Western Himalayas, we collected plants of *Cyntomium hookerianum* (Presl) C. Chr. from Gwaldam. This species has not been reported from Western Himalaya being known so far from nepal, Bhutan, Khasia hills, Meghalaya, Nagaland, China, Tonkin, Japan, Taiwan and Australia. The present collection extends its distributional ranges further west to Kumaun Himalaya, and is an important addition to the fern flora of North—Western Himalaya. The voucher specimens are lodged in the Herbarium of Department of Botany, Kumaun University Campus, Almora.

**Cyrtomium hookerianum** (Presl) C. Chr., Ind. Fil. Suppl. 1, 101, 1913; Jamir & Rao, Ferns of Nagaland, 334, 1988; Dixit, Cens. Indian Pterido. Ser. 4, 1984.*Lastrea hookeriana* Presl, Tent. Pterid., 77, 1836. *Aspedium caducum* Wall. ex Hook. et Grev., Icon. Fil. t.171, 1829 (non HBK, 1815).*Cyrtomium caducum* (Wall. ex Hook. et Grev.) Moore, Ind. Fil. 276, 1861; Bedd., Handb. Ferns Brit. India, 211, 1883.*Phanerophlebia hookeriana* (Presl) Copel., Gen. Fil., 3, 1947.

Rhizome stout, short, erect with spreading wiry roots. Stipe upto 30 cm long, stout, covered with dark brown, lanceolate, acuminate scales (upto 30 mm at base and 6ã mm at middle and onwards). Lamina 35–45 x 15 x 2 cm, simple pinnate, pinnatifid at apex; lateral pinnae upto 27 pairs, slightly oblique to the rachis, shortly petiolate; largest pinnae upto 15 x 1.5–2.5 cm, petiolate, falcate, cuneate at the base, acuminate at the apex, margin toothed, texture coriaceous, glabrous above and scaly beneath (scales upto 1.5 mm long); rachis and costules sparsely covered with small brown scales; veins free, much forked. Sori globose, scattered; indusium peltate with slightly lobed margin; sporangia stalked; spores not matured.

*Ecology:* Rare, growing along the banks of perennial streams in dense forests at an altitude about 2000 m.

*Specimens examined:* Kumaun Himalaya, District Almora, Gwaldam (2000 m), P.C. Pande, 17057.

### ACKNOWLEDGEMENTS

We are grateful to Dr S.P. Khullar, Punjab University, Chandigarh for sending relevant literature. Financial assistance from CSIR, New Delhi is thankfully acknowledged.

P.C. PANDE
H.C. PANDE

April 15, 1989.

## 49. *CARALLUMA NILAGIRIANA* KUMARI AND SUBBA RAO (ASCLEPLADACEAE) — A NEW RECORD FROM KARNATAKA

*Caralluma nilagiriana* was reported as a new species for India by Kumari and Subba Rao (1976) based on the specimens collected on way from Anaikatti and Ebanad in Nilgiri District, Tamil Nadu, in rocky areas at 900 m altitude. They considered this species as allied to *C. truncato—coronata* but differentiated from it on the basis of the characters such as non—succulent roots, deltoid leaves, pellucid glands on the external parts of corolla and others.

The present collection was made from a lateritic hilly area in GKVK campus of the University of Agricultural Sciences, Bangalore, at an altitude of 800 m. This species is likely to escape attention as the plants are ephemeral and appear only in a small patch of area among bushes partially exposed to sunlight. When a closer observation is made the plant appears striking with its small stature, erect branched stem up to 10 cm height, 6–9 dark purplish flowers in terminal umbel quite large to the size of the plant.

*Caralluma nilagiriana* appears to multiply chiefly by root suckers and hence they occur in patches. The flowers open after 9.00 in the morning and remain open until next day and then fall. Fruits were not observed on any plant. In all other characters the plants resemble *Caralluma nilagiriana* described by Kumari and Subba Rao (1976). Thus, the present report has shown that this taxon is not endemic to Nilgiri District but also occurs elsewhere.

*Coll.:* V. Bhaskar and C.G. Kushalappa, 796, UAS, GKVK, Bangalore North, Karnataka, 2 September 1988, alt. 800 m. Specimens are deposited at Herbarium, Department of Farm Forestry, UAS, GKVK, Bangalore.

V. BHASKAR
December 10, 1988. C.G. KUSHALAPPA

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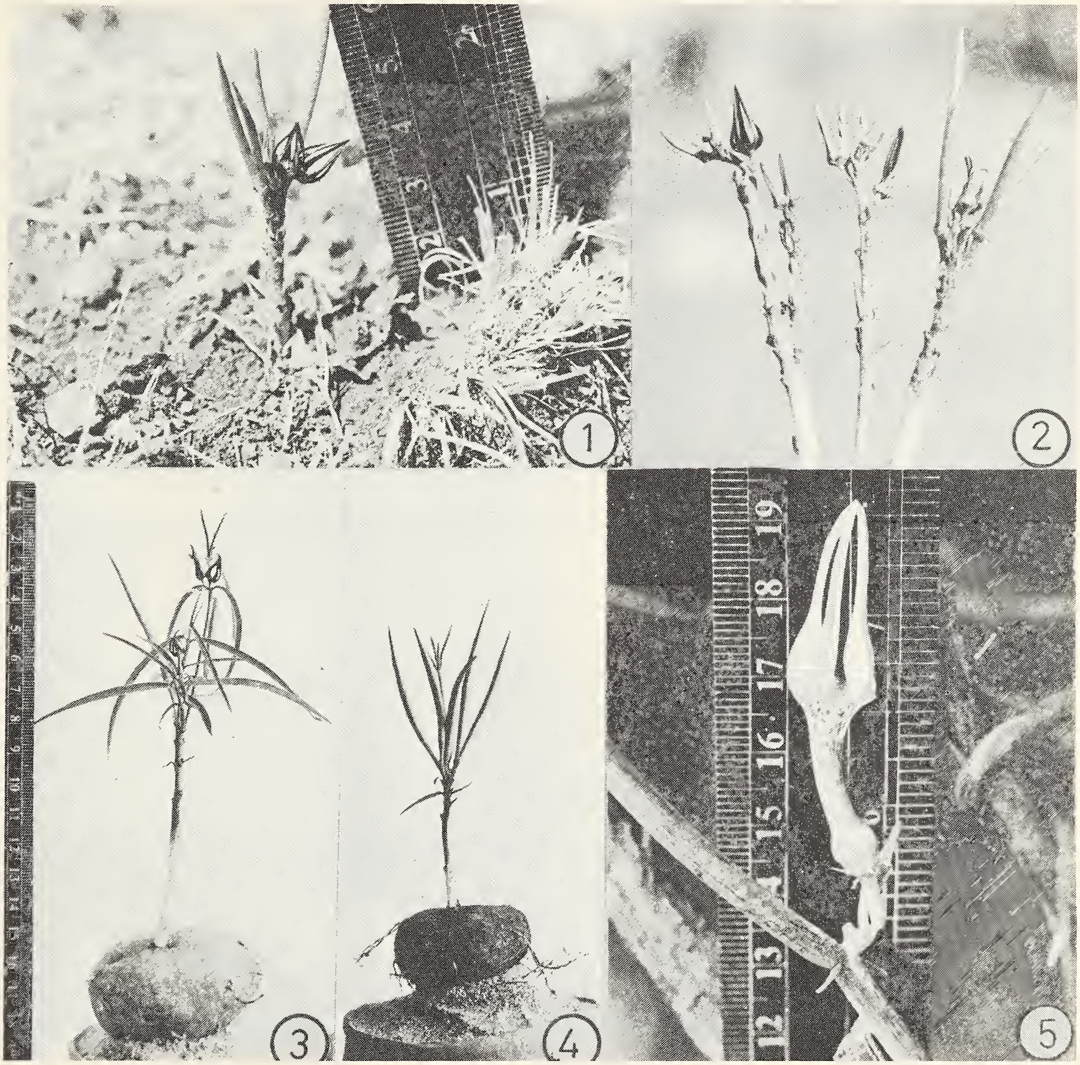
## 50. TWO NEW RECORDS OF ASCLEPIADACEAE FROM MAHARASHTRA

*(With a plate and twelve text–figures)*

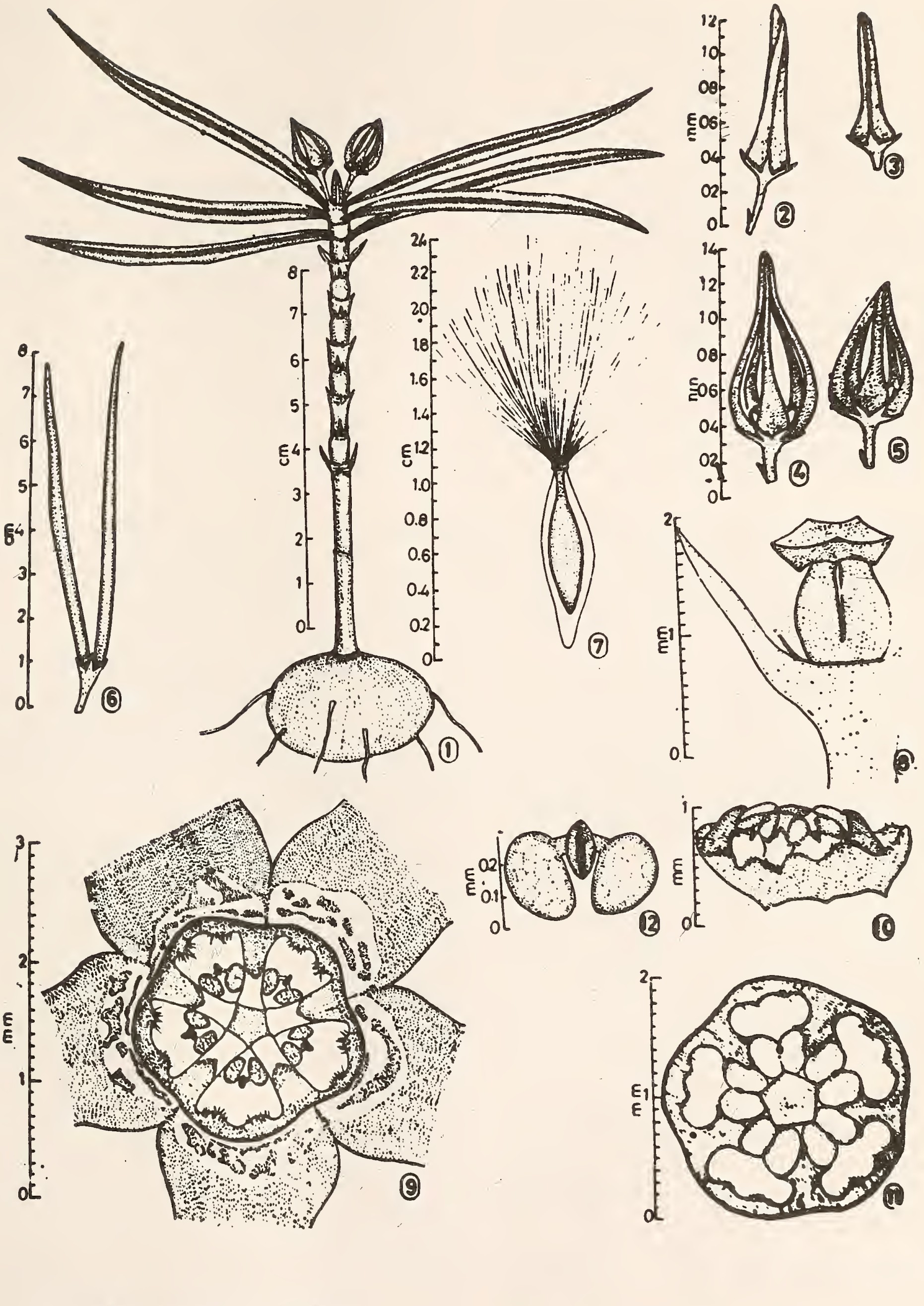
During the course of exploration of rare, endangered and endemic plant species of Maharashtra, the following two interesting plants of Asclepiadaceae were collected from Kolhapur and Satara districts of the State. *Brachystelma edulis* Coll. and Helmsl. which is originally known from upper Burma and Siam (Thailand) is collected from Kolhapur district (Yadav–3601) and forms a new record for India.*Ceropegia juncea* Roxb. has been collected from Satara district (Yadav—4020) and forms a new record for Maharashtra State. As these two species form new reocrds from Maharashtra, descriptions with plate and figure are presented here.

1) *Brachystelma edulis Coll.* and Helmsl. in Journ. Linn. Soc. 28:89, t. 14, 1890.

An erect perennial dwarf herb, 5–12 cm in height with subglobose or depressed tuberous root, tubers 2–10 cm in diameter. Stem terete, 2–3 mm in diameter, branched or unbranched, covered with short downwardly pointed hairs. Leaves sessile or subsessile, linear to linear—lanceolate to narrowly elliptic, 3–8 x 0.4–1 cm, acute, margins ciliate. Flowers 1–2 on lateral side of scaly or foliaceous leaves, bracteate, small; pedicel 3–8 mm, puberulous, bract subulate, 1–2 mm. Calyx 5–partite, sepals 1.3–1.5 x 0.4–0.5 mm perberulous. Corolla 0.6–1.2 cm long, straight, divided almost to the base, dark purple and variously varigated on inner side, pale–green–purple outside, corolla tube short c. 1.5 mm, corolla lobes, broad at base tapering and filiform at apex, connate and twisted at tips, usually glabrous or sparsely hairy on inner side. Corona biseriate, 2–2.5 mm in diameter, outer corona cupular of 5—bifid lobes, lobes glabrous outside, hairy on margins and inner side or rarely entirely hairy; inner corona of 5 dark purple procumbent processes which bent upon stigma, usually glabrous or sparsely hairy, each process usually trifid at apex with 2 small lateral lobes and one large middle lobe procumbent on stigma. Pollinia erect, minute, yellow attached to brown carriers by short caudicles. Pistil 1–2 mm long, style indistinct, stigma pentangular and fleshy. Follicles usually in pairs; 5–11 x 0.2– 0.3 cm, horn—shaped, tapering at apex. Seeds 8–12



1-4: *Brachystelma edulis* Coll. & Helmel. 5: *Ceropegia juncea* Roxb.



Figs. 1-12. *Brachystelma edulis* Coll. & Helmsl.
1. Plant; 2 & 3. Flowering buds; 4 & 5. Open flowers; 6. Follicle; 7. Seed with coma; 8. Pistil; 9. Plan view of flower; 10. Side view of corona; 11. Plan view of corona; 12. Pollinia.

x 2–3 mm, elongated, margined, coma 1–1.5 cm long, white.

*Note:* The species grows on borders of slopes on hillocks and in grasslands. Flowering of the species is very peculiar. After first showers of premonsoon in mid—May, the plants sprout out and initially produce scaly leaves. On lateral side of each scaly leaf 1 or 2 flowers are produced, usually one on each side of scaly leaf. After flowering and fruiting, the plants produce foliaceous leaves. Rarely flowers, fruits and foliaceous leaves are produced simultaneously. Main flowering season is May to June. Then after vegetative growth is continued upto August and then the leaves and above ground parts of stem die off.

2) **Ceropegia juncea** Roxb., Pl. Corom. 1: 12, t. 10, 1795.

Twining or prostrate, glabrous, fleshy, perennial herbs, when prostrate rooting at nodes, tubers small with many branched roots. Stem with distinct nodes and internodes; internodes 5–12 cm long and 3–5 mm in diameter, thick, fleshy, green, glabrous. Leaves scalelike, c. 1 cm x 2 mm or absent. Cymes pedunculate, usually 2–3 flowered. Pedicels 6–7 mm long, thick. Calyx 5 partite, sepals 3–4 mm long. Corolla 3.5–4.5 cm long, corolla tube inflated at base, funnel shaped above the middle, slightly curved, c. 2.5 cm long, variegated with purple outside, dark purple inside, corolla lobes 2 cm long, greenish – yellow, adhering at tip. Outer corona of 5 bidentate – deltoid ciliate lobes, c. 4 mm in diameter; inner corona of linear, erect, hooked lobes, lobes c. 3.5 mm long. Follicle in pairs, c. 4 cm long.

*Note:* Very rare plant in Maharashtra and found growing on hilly slopes. The branches coming in contact with soil produce roots at nodes and form small tubers.

We are thankful to Director, Royal Botanic Gardens, Kew for confirming the identification of *Brachystelma edulis*. Coll. & Helmsl.

S.R. YADAV
C.B. SALUNKHE
G.B. DIXIT

January 27, 1989.

## 51. DISPERSAL OF WILD LIME *ATALANTIA MONOPHYLLA (L.)* CORR. SERR. (RUTACEAE) SEEDS BY SHORTNOSED FRUIT BAT *CYNOPTERUS SPHINX* VAHL IN POINT CALIMERE WILDLIFE SANCTUARY, SOUTH INDIA.

Van der Pijl (1982) while discussing the various principles involved in the dispersal of higher plants, mentioned that citrus fruits (hesperidia) deviate from the ornithochorous type by possessing an indehiscent, repellent, tough pericarp and by the large seeds, which separate easily from the sweet pulp when pecked at. He further comments that this type of fruit is fit for dispersal by monkeys, but there is no data available on the dispersal of these seeds in the natural environment.

However, Ridley (1930) cited data from Jamaica, where certain birds such as *Icterus leucopteryx* and *Turtur leucopteryx* feed and disperse the seeds of cultivated oranges. Also instances of cultivated citrus fruits damaged by birds for the sake of seeds is reported from Northern Australia (Van der Pijl 1982) and Pakistan (Shafi *et al.* 1986).

At Point Calimere Wildlife Sanctuary during a two year study on the seed dispersal by fruit–eating birds and mammals, I found that the fruits of *Atalantia monophylla* (citrus type) were eaten and dispersed by Shortnosed Fruit Bat *Cynopterus sphinx* Vahl (Megachiroptera).

**Atalantia monophylla** (L.) Corr. Serr. (Rutaceae) is an evergreen small thorny tree, distributed in the peninsular India, Sri Lanka and Khasia hills (Mathew 1982). The fruit (hesperidia) is a green globose berry with thick rind and bitter taste; 2 cm diam.; 1–5 celled; cells 1 seeded; seeds 1.3 x 1 cm diam. This species is common in Point Calimere Sanctuary and its Peak fruiting was observed in October and November.

Shortnosed Fruit Bat is a commonly noticeable small at at Point Calimere Widlife Sanctuary. It visits the fruiting trees, plucks the fruits, carries them in its mouth, flies to a nearby tree and eats at leisure. The fruits are chewed and the seeds are spat out along with the uneaten parts. The spat out seeds found under the feeding roosts were collected twice in a week. Totally 309 samples were collected from January 1987 to December 1987. Seeds of *atalantia monophylla* were found in 50.5% of the samples collected. In December 1987 four samples comprising 46 *A. monophylla* seeds were left *in situ* to determine whether they will germinate or not. During January '88, immediately after the monsoon rains, 29 seedlings were found growing in the marked sites. From this observation it is evident that the *A. monophylla* fruits are eaten and dispersed by Shortnosed Fruit Bat. This note forms the first record of citrus type fruit dispersel by a suitable disperser, mammal in the natural environment.

ACKNOWLEDGEMENTS

My sincere thanks are due to my research guide, Prof. P.V. Bole, President, Bombay Natural History Society for his guidance and Mr J.C. Daniel, Curator, of the same institution for his encouragement.

March 31, 1989. P. BALASUBRAMANIAN

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## ERRATA

### VOLUME 86 (1) : APRIL 1989

Notes on the status and distribution of some birds in Sri Lanka
**For** migrant
**Read** vagrant

### VOLUME 86(3) : DECEMBER 1989

105th Annual Report and Accounts

To list of office bearers
**Add :** *Vice President* Mr. K. T. Sataravala

## BOMBAY NATURAL HISTORY SOCIETY

### Minutes of the AGM held on 22—11—1988

The Annual General Meeting of the Bombay Natural History Society was held on Tuesday, the 22nd November 1988 at 6.00 p.m. at Hornbill House, when the following were present:

1. Prof. P V Bole (In the Chair)
2. Mrs D S Variava
3. Mr S S Nadodwalla
4. Mr Bharat Bhushan
5. Mr D B Jamdade
6. Mr S Krishnan
7. Mr Secunder A Padsha
8. Mr S F Tarapore
9. Mr D J Ugaonkar
10. Mr M S Behramfram
11. Mr Mukesh Dialani
12. Mr Sunil R Zaveri
13. Dr Pratap Saraiya
14. Ms Heta Pandit
15. Mr Debi Goenka
16. Mr N D Mulla
17. Mr Kisan Mehta
18. Prof. Parvish Pandya
19. Mr G Bromilow
20. Ms Usha Shah
21. Dr A N D Nanavati
22. Mr Promode Kant
23. Mr J C Daniel
24. Mr S Solomonraj
25. Dr C V Kulkarni
26. Mr N D Sethna
27. Dr Asad Rahmani
28. Mr M R Almeida
29. Mr Mihir Devare
30. Mr Nitin Jamdar
31. Dr Shashi Menon
32. Mr S P Kamath
33. Mr Ulhas Rane
34. Mr Shakunt Tari
35. Mr Ravi Sankaran
36. Mr R S Moral
37. Mr K P Karamchandani
38. Mrs P Lalkaka
39. Ms S Worah
40. Mr Owen Joseph Fonseca
41. Mr S G Bhatkal
42. Mr S Mistry
43. Dr Meena Haribal
44. Mr S R Mehta
45. Mr S D N Gandhi
46. Ms Archna Mehrotra
47. Mr Carl D'Silva
48. Ms Iyer Shashi Rekha
49. Mr Y U Bulsara
50. Mr Sangeet Sharma
51. Mr S D Swatantra
52. Mr R K Ojha

**Agenda Item 1:** The Chairman proposed that the minutes of the Annual General Meeting held on 18th December 1987 and the Minutes of the Extraordinary General Meeting held on 26th March 1988, which had been circulated in draft form to the members who had attended the meeting and thereafter finalised by Chairman, be received.

Mr Mulla pointed out that his suggestion that the results of the Referendum on the representation of the Central and State Governments on the Executive Committee should be circulated to all members of the Society had not been incorporated. It was resolved unanimously that this would be done. The minutes were accepted with the above modification.

**Agenda Item 2: The Honorary Secretary's Report:** The Honorary Secretary's report which was available was taken as read.

The Honorary Secretary further stated that the Government of India have now sanctioned the organisation of a Centre for Ornithology and that arrangements are being made to register a separate Society under the auspices of the BNHS for the management of the 100% government funded centre which will be named after Dr Salim Ali.

The members expressed appreciation at the fulfilment of Dr Salim Ali's desire.

In the discussion the report, Mr. Mulla pointed out discrepancies of time—lag in the publication of certain articles in the Journal. The Chairman said the matter would be looked into and explanation, if any, provided.

It was pointed out by Mr. Debi Goenka that there was no mention of the Reference Collection nor of the Hebarium in the Honorary Secretary's report. The Honorary Secretary expressed regret for this oversight. Mrs D S Variava pointed out that in future reports the Chairpersons of the various sub—committees would be reporting on the activities of their respective sub— committees which would be incorporated in the Honorary Secretary's report.

The Honorary Secretary's Report was then accepted.

**Agenda Item 3: Accounts:** The Honorary Tresurer gave a resume of the financial situation of the Society as a corallary to the report he had already submitted.

Inquiries regarding utilization of certain funds and investments were made together with suggestions. Explanation of queries were given. Suggestion of other permissible investments will be looked into by the Society, particularly with ref. to UTI investments under Trust Security act, as suggested by Mr. Debi Goenka.

Mr. S A Padsha suggested that the percentage set apart for the Society from amounts collected for field trips should be indicated to members. The Hon. Treasurer stated that he would consider the suggestion.

The Annual Accounts for 1987 were then approved.

**Agenda Item 4: Appointment of Auditors:** Messrs Habib and Co. Auditors, were re—appointed for the ensuing year, at a remuneration to be fixed by the Executive Committee.

**Agenda Item 5: Any other business:** Mr Mulla announced that he would send a requisition duly signed by several members for holding an E.G.M. to discuss the conduct of the last referendum.

The meeting terminated with a vote of thanks to the Chair.

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| Narayan, E. | Dept. of Microbiology, JIPMER, Pondicherry 605 006 | 445 |
| Navarro, A. | St Xavier's High School, Bombay 400 001. | 451 |
| Pande, H.C. | Dept. of Botany, Kumaun University Campus, Almora 263 601. | 479 |
| Pande, P.C. | Dept. of Botany, Kumaun University Campus, Almora 263 601. | 479 |
| Patil, G.M. | Dept. of Sericulture, University of Agricultural Sciences, GKVK Campus, Bangalore 560 065 | 472 |
| Pravez, Rishad | Dept. of Biosciences, Saurashtra University, Rajkot, Gujarat 360 005 | 440 |
| Punetha, N. | Dept. of Botany, Govt. P.G. College, Pithoragarh 262 501 | 475 |
| Rahmani, Asad R. | Bombay Natural History Society, Hornbill House, Shaheed Bhagat Singh Road, Bombay 400 023. | 447 |
| Rajan, S. Alagar | BNHS Avifauna Project, Pt. Calimere Tanjavur Dist., Tamil Nadu 614 807. | 450 |
| Rajasekaran, M. | Dept. of Zoology, University of Rajasthan, Jaipur, Rajasthan 302 004. | 461 |

| | | |
|---|---|---|
| Raju, U.V. Bairagi | A.P. Natural History Society, Kingfisher House, Near A.U. Post Office, Visakhapatnam 530 003. | 449 |
| Raju, K.S.R. Krishna | A.P. Natural History Society, Kingfisher House, Near A.U. Post Office, Visakhapatnam 530 003. | 449 |
| Ranade, Sunil | 10, Pranav Society, 1000/6-C, Navi Peth, Pune 411 030 | 446 |
| Ranjitsinh | Ministry of Environment & Forests, Kota House Hutments, Shahjahan Road, New Delhi 110 011 | 435 |
| Reddy, Prasad N.A.V. | Dept. of Environmental Sciences, Andhra University, Visakhapatnam 530 003. | 467 |
| Redman, N.J. | 14, Sandiway Place, Altrincham, Cheshire, WA14 1HT U.K. | 460 |
| Salunkhe, C.B. | Dept. of Botany, Shivaji University, Kolhapur 416 004. | 480 |
| Sankaran, Ravi | Bombay Natural History Society, Hornbill House, Shaheed Bhagat Singh Road, Bombay 400 023. | 451 |
| Sant, Niranjan | 10, Pranav Society, 1000/6-C, Navi Peth, Pune 411 030 | 446 |
| Santharam, V. | No. 68 (I floor), Santhome High Road, Madras 600 028. | 452 |
| Sanyal, D.P. | Division of Herpetology, Zoological Survey of India, Jawaharlal Nehru Road, Calcutta 700 016. | 462 |
| Savanurmath, C.J. | Dept. of Zoology, Karnatak University, Dharwad 580 003. | 472 |
| Shafee, Adam S. | Dept. of Zoology, Vaish College, Rohtak | 468 |
| Sharma, Satish Kumar | Van Chetana Kendra, Gulab Bagh, Udaipur, Rajasthan 313 001. | 453,455,456 |
| Shrestha, Mukti N. | Dept. of National Parks & Wildlife Conservation, Central Zoo, Jawalakhel, Lalitpur, Nepal. | 438 |
| Singh, B.P. | Dept. of Botany, SGN Khalsa College, Sriganganagar, Rajasthan. | 473 |
| Singh, Ravinder | 41, Panchwati, Udaipur, Rajasthan 313 001. | 456 |
| Smetacek, Peter | The Retreat, Bhimtal, Nainital, Uttar Pradesh. | 471 |
| Sodhi, Navjot S. | Dept. of Zoology, Panjab University, Chandigarh 160 014.<br>Present Address: Dept. of Biology, University of Saskatchewan, Saskatoon, Saskatchewan S7N OWO, Canada. | 440 |
| Talukdar, S.K. | Division of Herpetology, Zoological Survey of India, Jawaharlal Nehru Road, Calcutta 700 016. | 462 |
| Tehsin, Raza | 41, Panchwati, Udaipur, Rajasthan 313 001. | 449,456 |
| Thomas, Shaju | Dept. of Zoology, Nirmala College, Muvattupuzha, Kerala 686 661 | 438 |
| Unnithan, S. | Bombay Natural History Society, Hornbill House, Shaheed Bhagat Singh Road, Bombay 400 023. | 451 |
| Uthaman, R.K. | Kerala Natural History Society, 13/369, Kammath Lane, Kozhikode, Kerala 673 002. | 458 |
| Varu, S.N. | Pipla Street, Junavas, Madhapur, Bhuj, Kutch | 443 |
| Venugopalan, R. | Kerala Natural History Society, 13/369, Kammath Lane, Kozhikode, Kerala 673 002. | 447,458 |
| Watve, Milind | 10, Pranav Society, 1000/6-C, Navi Peth, Pune 411 030 | 446 |
| Yadav, S.R. | Dept. of Botany, Shivaji University, Kolhapur 416 004. | 480 |

# 105TH **ANNUAL REPORT AND ACCOUNTS**
## 1988-89

| | |
|---|---|
| *Patron* | Mr Rajiv Gandhi, Prime Minister of India |
| *President* | Prof. P V Bole |
| *Vice Presidents* | Mr Humayun Abdulali; Mrs. D S Variava |
| *Hon. Secretary* | Dr A N D Nanavati |
| *Hon. Treasurer* | Dr Pratap R Saraiya |
| *Curator* | Mr J C Daniel |

*Executive Committee*

Mr M R Almeida; Dr. Erach K Bharucha; Dr B F Chhapgar
Mr Cyrus J Guzder; Dr (Ms) Meena Haribal; Mr K Karamchandani
Mr Kisan Mehta; Prof. Parvish Pandya; Mr Ulhas Rane; Mr D I Solanki
The Secretary, Dept. of Education and Social Welfare, Govt. of Maharashtra

*Auditors*

M\s Habib and Company, Chartered Accountants, Bombay

## BOMBAY NATURAL HISTORY SOCIETY

*Registered Office:* Hornbill House, Shaheed Bhagat Singh Road, Bombay 400 023.

# REPORT OF THE COMMITTEE FOR THE 15 MONTH PERIOD ENDED 31 MARCH 1989

## 105TH "ANNUAL" REPORT

### MEMBERSHIP

The Membership of the Bombay Natural History Society (BNHS) remained more or less static and showed only a marginal increase in 1988 over 1987 as shown below:

| | *As on 31st December* | | | | |
|---|---|---|---|---|---|
| Type of membership | 1984 | 1985 | 1986 | 1987 | 1988 |
| Ordinary Members | 1762 | 1764 | 1680 | 1960 | 2008 |
| Corporate Members | 132 | 152 | 138 | 81 | 83 |
| Life Members | 562 | 639 | 737 | 986 | 1057 |
| Compound Corporate Members | 107 | 108 | 115 | 115 | 115 |
| Student Members | 192 | 164 | 141 | 190 | 206 |
| Honorary Members | 3 | 3 | 3 | 3 | 3 |
| Vice Patrons | 6 | 6 | 6 | 6 | 6 |
| Centenary Life Members | 3 | 3 | 3 | 3 | 3 |

It is hoped that with the increase in members' activities generated by the various Sub-Committees constituted by the Executive Committee, membership will increase considerably in the coming months. The strength and independence of an organisation like the BNHS depends on its ability to attract and increase its membership.

### FIELD PROGRAMMES

Membership and Programmes Sub-Committee

*Chairperson* : Dr (Ms) M. Haribal
*Convenor* : Mr Naresh Chaturvedi
*Members* : Mr Parvish Pandya
Dr A. Kothari
Mr Kisan Mehta
Dr A.N.D. Nanavati, Hon. Secretary } Ex-officio
Dr Paratap Saraiya, Hon.Treasurer } Ex-officio
Mr J.C. Daniel, Curator } Ex-officio

With the assistance of many members who volunteered their services for guiding members in field outings and other programmes, the Programmes Sub-Committee could undertake a large number of field activities as described below:

During the year under review, members in the Bombay area were taken on nature walks to areas of natural-history interest such as Mamabanja, Chinchoti falls, Kukoba hills, Uran, Jambulwadi, Karnala Bird Sanctuary, Kehim Sea Shore etc. The seashore outings were particularly well attended. Besides weekend camps were organised at Gaurapur, Jaikwadi, Castle Roack, Prabalgad, Sawantwadi, Malshejghat, Suriamal, Nandur Madhmeshwar and Palgar. We are examining the feasibility of arranging field programmes in other parts of the country for members of the BNHS.

Three major field camps were held during the year. The first was a high altitude camp in Sikkim State which enabled members not only to trek but also to watch the birds and study the rich butterfly and other fauna and flora of the eastern Himalayas. The camp was for 11 days and 3 batches of members trekked from 3000 ft to 13,000 ft.

The second camp was held in the Manas Sanctuary in Assam, one of the best sancturies in India and a world heritage site which holds several endangered species, including the hispid hare and Pygmy hog. The third camp was held at Ranthambore Sanctuary in Rajasthan, a Tiger Project area as is Manas. The members in 3 batches stayed for 5 days and 4 nights to look at the tiger and other interesting fauna and flora and observe problems of management of the protected area.

The other programmes at Bombay included film shows and lectures by guest lectures and BNHS members and Research Staff. Exhibitions of photographs on wildlife and of stamps were also held.

### PUBLICATIONS

Publication Sub-Committee

*Chairperson* : Mr C.J. Guzder
*Convenor* : Mr J.C. Daniel
*Member* : Dr B. Chhapgar
Dr A.N.D. Nanavati, Hon. Secretary } Ex-officio
Dr Pratap Saraiya, Hon. Treasurer } Ex-officio

The Publications Sub-Committee undertook the task of reorganisation of the publication structure of the BNHS Journal and the results can be seen in the coming year. The Sub-Committee also propose to reorganise the processing and management of the publications of the BNHS.

In 1987, the Honorary Treasurer, with the approval of the Executive Committee, negotiated an arrangement for the worldwide distribution of the Society's publications by the Oxford University Press. Under this arrangement, except for sale to members at concessional rates by the Society, all other sales are being handled by the OUP. This arrangement has proved to be highly advantageous to the Society and has resulted in the reprinting, within a short period, of most of the popular publications of the Society.

**Journal:**

265 notes and articles were received from members and others for publication in the Journal during the year. From among these and notes and articles received earlier, 157 were accepted for publication.

During the year, 4 issues of the Journal i.e., vol. 84(2&3) and vol. 85(1&2) were published. The 956 pages of these Journals held 247 articles and notes.

**Hornbill:**

The two issues of the first two quarters of the magazine were published in the usual format. The remaining issues were combined into one as the Salim Ali special issue of the 'Hornbill'. The Hornbill continues to be popular and to attract members. Under the revised rules, this magazine is sent free to all members of the BNHS while the Journal now requires a separate subscription.

## NATURE EDUCATION SCHEME

Nature Education Sub-Committee

| | | |
|---|---|---|
| *Chairperson* | : Mr U. Rane | |
| *Convenor* | : Mrs S. Grubh | |
| *Members* | : Ms M. Haribal | |
| | Mr S.A. Hussain (ODA) | |
| | Dr Arun Joshi | |
| | Ms Heta Pandit | |
| | Mr Parvish Pandya | |
| | Dr A.N.D. Nanavati, Hon. Secretary | Ex-officio |
| | Dr Pratap Saraiya, Hon. Treasurer | |
| | Mr J.C.Daniel, Curator | |

The regular activities like field trips, slide shows, camps, competitions etc. involving schools and colleges in Bombay were continued during the year. 20 programmes of slide/film shows and talks were conducted for schools, colleges and nature clubs in Bombay. These included Municipal schools and teachers' colleges. 41 field trips were organised for schools and colleges at Borivli National Park and Tansa Sanctuary. Additionally, 17 study visits were organised for schools to the Natural History Section of the Prince of Wales Museum, Jijamata Udyan and Taraporewala Aquarium. A quiz programme for schools and junior colleges was organised on World Forestry Day. A vacation camp for children was organised in co-ordination with R.C.F. club.

The Nature Education Sub-Committee members carried out various educational programmes for the BNHS members, college students and rural children. These included slide shows, film shows, exhibitions, nature trails, competitions in photography, basic courses in natural history subjects, nature orientation camps for members and armed forces personnel, awareness programmes on tree conservation and publicity through newspapers, radio and television. A teachers' camp was organised at Bharatpur.

The special features of the programmes conducted in the year 1988 were:

1. Involvement of more voluntary organisations in our rural programmes.
2. Active involvement of the BNHS staff and members in the nature education activities.
3. Beginning of nature education courses for amateurs.
4. Extension of nature education activities to Karnataka and Gujarat with the help of our members in these states.
5. Conservation workshop at Kota for army officers. This is likely to be an annual feature, in future.
6. A unique syllabus is being prepared for tribal children (who do not get the facilities like schools, books etc.) to orient them towards nature conservation with a scientific approach. This experiment is being carried out at Murbad, in Thane district in co-ordination with Lokvidnyan Chalwal and Shramik Mukti Sanghatana.
7. Compilation of educational literature on natural history in English and Marathi.
8. An Orientation Camp for selected teachers from Bombay at Bharatpur wasorganised.

## COLLECTIONS

Collections Sub-Committee

*Chairperson* : Mr H. Abdulali
*Convenor* : Mr N. Chaturvedi
*Members* : Dr M. Almeida
Dr B. Chhapgar
Ms M. Haribal
Mr N. Jamdar
Staff in charge of different collections
Dr A.N.D. Nanavati, Hon. Secretary
Dr Pratap Saraiya, Hon. Treasurer } Ex-officio
Mr J.C. Daniel, Curator

The BNHS presently holds a reference or study collection of 18000 + mammals, 26,000 + birds, 7,000 + reptiles and amphibians and over 50,000 insects, a collection of birds, a collection of birds eggs and a small collection of shells. The purpose of the collection is to assist in taxonomic studies.

### Mammals:

Assistance was given to Ms Chandran who had planned an ecological study of Indian rodents. Another scholar, Mr Sundaraj, collected data on eye measurements. Dr Allan Rodgers of the Wildlife Institute studied skulls of Cervidae and Bovidae in the collection. Hair samples from the collections were sent to Dr Johnsingh to help in the identification of hairs in scats. Otter specimens were studied and a key was prepared for their identification. A presentation on Otter identification was given at the Otter Symposium held at Bangalore.

The work of computerising the data of the mammal collection was begun.

### Birds:

The systematic cataloguing of the collections by Mr Humayun Abdulali was continued during the year. Under this programme, specimens of *Zoothera* and *Turdus* were sent to the British Museum for opinion. Specimens were also given on loan to various workers for studies. 47 specimens of birds collected from Arunachal Pradesh in October 1988 and 28 specimens from Mandapam and Point Calimere bird ringing camps were added to the collections.

### Reptiles:

Collection of amphibians made by the Oxford University Students Expedition to the Srivilliputur Hills, Tamil Nadu, was identified. Similarly, specimens received from Dr S.K. Dey, collected by him from Sikkim were also worked out. A small collection received from Dharwad (Dr Kanmandi) and Kerala (Dr M I Andrew) were identified and returned. Specimens of the Cobra *Naja naja* were sent to Dr R S Thorpe, Department of Zoology Aberdeen, U K for study.

### Insects:

A small collection of Butterflies received from the Oxford University Students Expedition was identified. Information on *Mantis* found in Maharashtra was given to a research worker from Pune. 40 butterflies collected from Parambikuiam area and Kashmir were added to the collections.

Besides students and staff of colleges and research institutions, several BNHS members from Bombay and outside visited the collections for reference, research and identification of specimens.

### Herbarium:

Specimens donated by Hindustan Ciba-Geigy were added to the collection. Over 212 specimens received from members and staff were identified.

A survey trip was made to the Surat Dangs with a member-researcher and plant specimens were collected and identified.

During the year 86, field trips were made to the BNHS land at Goregaon and plants of 153 quadrats of 10 x 10 m were identified and studied. The data has been entered in the computer and will be analyzed.

## NATURAL HISTORY STUDIES

Natural History Studies Sub-Committee

*Chairperson* : Dr E. Bharucha
*Convenor* : Mr S.A. Hussain
*Members* : Mr M. Almeida
Mr Bharat Bhushan
Prof P.V. Bole
Dr B. Chhapgar
Mr Rishad Naoroji
Mr Ulhas Rane
Dr A.N.D. Nanavati, Hon. Secretary
Dr Pratap Saraiya, Hon. Treasurer } Ex-officio
Mr J.C. Daniel, Curator

A Sub-Committee was set up this year with the objective of encouraging studies in various fields of Natural History by members and students. The committee was assigned the following funds with specific objectives.

| | Name of the Fund | Objectives |
|---|---|---|
| 1. | Salim Ali Loke Wan Tho Ornithological Research Fund | To provide an opportunity, through grant of fellowships or otherwise to undertake study and research on problems of Field Ornithology |
| 2. | Pirojsha Godrej Field work Fund | To provide assistance for research and training on environmental ecology. |
| 3. | Sir Dorab Tata Trust Field work Fund | To promote field work and research in Natural History. |
| 4. | W. Boolchand Trust Fund | To provide scholarships for the study of Ecology & Ornithology. |
| 5. | Plant Studies Fund | To provide for research and conservation of floristic elements and studies on inter-relationship between plants and animals. |

It was decided as a preliminary exercise to identify members interested in various aspects of natural history by setting up study groups for members in Botany, Forest Ecology, General Ecology, Ornithology, Mammals Herpetology, Insects and Archnids, Aquatic Fauna and Geology to build up a suitable data bank for this purpose. But the response to the announcement made in the Hornbill about the study groups was negligible.

Some of the activities of the Sub-Committee funded and generated during the year were:

**1. ICBP Membership:**

The BNHS was made a subscribing member by providing funds towards subscriptions to the International Council for Bird Preservation (ICBP). It was felt that it would be advantageous to BNHS to become a member of ICBP and initiate moves to set up an ICBP Indian National Section under the leadership of BNHS and with the collaboration of other NGO's.

**2. Waterfowl and Wetlands Newsletter:**

The BNHS, in association with the International Wetlands and Waterfowl Research Bureau, conducted the Asian midwinter waterfowl counts in India. Over three hundred birdwatchers, most of them BNHS members, participated in the count. The results of the counts were compiled in a newsletter "Wetlands and Waterfowl", partly funded by the NHS Sub- Committee. The newsletter was distributed to all the participants as well as key personnel in India and abroad.

**3. Photographic record of BNHS land in Goregaon:**

The BNHS collection staff have been carrying out Natural History Studies in the land alloted to BNHS at Goregoan. A support grant was given to keep a photographic record of the flora and fauna of the area at different times of the year and record their natural cycle.

**4. Other studies — M. Phil thesis:**

a] Two students of the AVC college, Mayavaram were awarded support grant so as to enable them to write up their respective M. Phil thesis. The students had worked at the Keoladeo National Park.

b] One student Mr. Maranko under the aegis of the BNHS field project had studied the wintering behaviour of the Siberian Crane.

c] Another student, Mr Neduraman, studied the habitat utilisation of the Siberian crane at Keoladeo National Park.

**5. Scholarship:**

A scholarship was awarded to Ms Mehrab

Johnson, of Osmania University, for the study on feeding and breeding biology of openbilled stork under the guidance of Prof. J V Ramana Rao. The field work is being carried out at Kolluru lake, Krishna Dist. and Puniakhesturan, East Godavari dist. Andhra Pradesh.

### 6. ICBP Asian Section Conference at Bangkok in April 1989:

Two of the BNHS scientists, Mr S.A. Hussain and Dr A.R. Rahmani were offered grants for attending the above conference for exchange of information on conservation and for establishing communication among the bird conservation organisations of Asia. At the conference, Mr Hussain read out the National status paper prepared by Mr Daniel as well as his own paper entitled "Bird Migration in Asia - a case for regional cooperation" while Dr Rahmani presented a paper on "Bustard Conservation in India".

Mr Hussain was elected as one of the two Vice-Chairmen for the ICBP Asian section for the next four years.

## THE SALIM ALI NATURE CONSERVATION FUND (SANCF)

SANCF Sub-Committee

*Chairperson* : Mrs D.S. Variava
*Convenor* : Mr Bharat Bhushan
*Members* : Dr E. Bharucha
Mr D. Solanki
Mr S.A. Hussain
Dr A.N.D. Nanavati, Hon. Secretary
Dr Pratap Saraiya, Hon. Treasurer } Ex-officio
Mr J.C. Daniel, Curator, Ex-officio

The Sub-committe continued to initiate as well as support activities of conservation interest from SANCF. Major undertaken projects during the year were:

1. A survey of the status of the Blacknecked Crane in Bhutan by Mr Prakash Gole and Col. Chacko. Mr Gole has presented the recommendations to the Royal Government of Bhutan.
2. A survey of the status of the Malabar Civet in the Elayur and Beypore areas of Kerala by Mr N.J. George of Calicut University. Mr George had earlier rediscovered the Malabar Civet after nearly fifty years.
3. A survey of the status of the Dugong in the Gulf of Mannar in Tamil Nadu by Dr Helene Marsh. The preliminary report has been received. The Tamil Nadu Forest Department have initiated follow-up action on the recommendations made in the report.
4. The Mangroves of the Krishna estuary in Andhra Pradesh were surveyed by Mr. Narendra Prasad. The recommendations have been followed up with the Andra Pradesh Forest Department and the area has since been declared as a sanctuary.
5. An aerial survey of the Surat Dangs in Gujarat by Dr E Bharucha was partially supported as part of other ecological studies of the Surat Dangs.
6. On the basis of a request for studies by the local NGO, Honavar Taluka Parisara Kuta, financial support was extended to Mr. Nitin Jamdar to conduct a short survey of the Sharavati Valley in Karnataka.
7. Wild Buffalo survey in Madhya Pradesh - SANCF sponsored a short survey with funds provided by the Department of Environment, Government of India, to record status of the Wild Buffalo populations in the Bastar and Raipur districts of Madhya Pradesh.

In addition, SANCF extended financial support for a) preparing an exhibition at Bombay on the "Save Sahyadris March"; b) organised a painting competition; and a quiz competition for students; and c) organising a nature discovery room for students at the BNHS.

A Conservation Officer was appointed during the year.

## PROJECTS

Projects Sub-Committee

*Chairperson* : Prof P.V. Bole
*Convenor* : Dr R.B. Grubh
*Members* : Mr H. Abdullali
Mr M. Almeida
Dr E. Bharucha
Mr. Karamchandani
Senior Scientists incharge of major projects.
Dr A.N.D. Nanavati, Hon. Secretary
Dr Pratap Saraiya, Hon. Treasurer } Ex-officio
Mr J.C. Daniel, Curator

During the year 1988 the BNHS handled six major field ecological research projects. These were:

1. Bharatpur (Keoladeo) Ecology Project (Funded by USFWS)
2. Bird Migration Project (Funded by USFWS)
3. Elephant Ecology project (Funded by USFWS)
4. Endangered Birds Project (Funded by USFWS)
5. Pt. Calimere Ecology Project (Funded by USFWS)
6. Bird Hazard to Aircraft Project (Funded by GOI)

### 1. Bharatpur Ecology Project

It is an extension of the original Bharatpur Hydrobiology project and the expected data of completion is April 1990. During the year, the 15 research staff headed by Dr V S Vijayan continued to collect data on various ecological parameters governing the Bharatpur wetland ecological system. The parameters included limnological aspects, vegetation, macro-invertebrates, fishes, herpetology, ornithology and mammalogy.

The number of fish species recorded within the Keoladeo National Park rose to 42. Two more amphibian species were collected. The population of aquatic birds was higher than during the previous year. The wintering population of the Siberian Crane did not settle down inside the park because of the drought.

### 2. Bird Migration Project

This is another extension project of the original project, 'Movement and population of Indian Avifauna. The expected date of completion is September 1992. Mr Hussain, the Project Scientist, and his team of five research staff handled the field programme as well as entering of banding data into the computer. Bird banding was conducted at Shivpuri, Karera (MP), Khabar Tal (Bihar), Hingolgadh (Gujarat), Point Calimere and Mandapam (TN). A total of 2224 water birds of 32 species were ringed during the year. Random netting was done at certain sites in order to assess the species composition of terrestrial birds.

### 3. Elephant Ecology Project

This project is an offshoot of the original 'Endangered Species' Project and is expected to continue until September 1992. The work is carried out by four research staff under the guidance of Mr J C Daniel. The major studies carried out during the year are i) feeding ecology of the elephants, ii) population dynamics, behaviour and conservation problems, and iii) migration of peripheral elephant population. The first two studies were carried out at the Elephant Project Field Station at Mudumalai (TN). The third study was initiated mainly to understand the possible reasons for the unpredictable movements of elephants in the existing degraded forests and even straying out into cultivation fields resulting in lethal encounters with man.

The areas covered were Hosur and Dharmapuri Forest devisions of Tamil Nadu, Chitoor division of Andhra Pradesh and Kanakapura division of Karnataka. The studies conducted at Mudumalai as well as on the peripheral populations of the elephants have given additional insight into the conservation and management problems of elephants. Additional studies were planned for elephants of Dalma in Bihar.

### 4. Endangered Birds Project

The 'Endangered Birds' project has so far completed an ecological study of the Great Indian Bustard and rediscovery of the Jerdon's courser. Two more species taken up under the Project for detailed study are the lesser florican and the Bengal florican. The second and final phase of this project is ending in September 1989. Dr A R Rahmani and three research staff form the team.

### 5. Point Calimere Ecology Project

Commenced in 1987, the Project aims at understanding the functioning of this complex ecological system with a view to offering management solutions to the forest department. Dr Y.N. Rao (Project head) and his four colleagues collected field data on the i) phyto sociology of the grazing lands, ii) plant animal interactions, iii) ecology of a few dominant bird species, and iv) ecology of the blackbuck. Additional aspects are to be taken up during 1989 in order to understand the dynamics of this ecological system.

### 6. Bird Hazard to Aircraft Project

At the request of the Government of India, the BNHS undertook to make an ecological study of 22

Indian aerodromes. The field work commenced in 1980 and concluded in 1988. During the last year, field work was limited to follow up observations at a couple of aerodromes with the help of one field staff. The GOI has now financed the BNHS to set up a Bird Hazard Research Cell to help identify bird remnants and to offer advice on bird hazard reduction. The final report of the study is under preparation.

## UNIVERSITY DEPARTMENT

During the year the department affiliated to the University of Bombay since 1957 continued to contribute to the Scientific Study of Natural History. Mr Vibhu Prakash submitted his thesis for the Ph.D degree in field ornithology, on "The General Ecology of raptors in Keoladeo National park" under the guidance of Mr J C Daniel.

Mr Manek Mistry submitted his thesis for Ph.D degree in Botany, on "Contributions to the flora of Ratnagiri dist. in Maharahstra" under the guidance of Prof. P V Bole.

The following students are registered for M.Sc and Ph.D degrees through the BNHS.

| Name of Student | Subject of Study | Guide from BNHS |
|---|---|---|
| | **M.Sc. Zoology** | |
| Mr S. Alagar Rajan | Ecology of Spotted and Ring Dove | Dr R.B. Grubh |
| Mr Gurmeet Singh | Ecology of Bank Myna | Dr R.B. Grubh |
| Mr Ramachandran | Ecology of the Jacanas | Dr V.S. Vijayan |
| Mr Ravi Sankaran | The Ecology of the Lesser Florican | Mr J.C. Daniel |
| | **Ph.D Zoology** | |
| Mr U. Sridharan | Ecology of the resident ducks of Keoladeo National Park | Mr J.C. Daniel |
| Mr G. Narayan | The Ecology of the Bengal Florican | Mr J.C. Daniel |
| Mr S.M.Satheesan | Birds of Prey | Mr J.C. Daniel |
| Mr Sunderamoorthy | The Ecology of terrestrial Birds of Keoladeo National Park, Bharatpur | Mr J.C. Daniel |
| Mr V. Natarajan | Ecology of the Crow-pheasant | Mr J.C. Daniel |
| | **Ph.D Botany** | |
| Mr P. Balasubramanian | Plant–animal Interactions | Prof. P.V. Bole |

## LIBRARY

Library Sub-Committee

*Chairperson* : Dr B. Chhapgar
*Convenor* : Mr Isaac Kehimkar
*Members* : Mr M. Almeida
Mr Kisan Mehta
Mr Kiran Srivastav
Dr A.N.D. Nanavati, Hon. Secretary
Dr Pratap Saraiya, Hon. Treasurer } Ex-Officio
Mr J.C. Daniel, Curator

The library continued to be a much used member facility. In 1988, 132 books were added to the library out of which 30 were purchased for the projects and 7 for the library. 12 books were sent by publishers for favour of publishing reviews in the *Journal* and 14 were received as complimentary copies from authors and publishers. Out of the 69 books received as donation, 29 books were donated by Mr. M. Hidayatullah, the Society's former President, and 20 books were donated by Mr A B Vakil.

The Govt. of India extended financial support for the purchase of a photocopier. It is now possible to attend to requests from members for reprints of articles etc. promptly.

The air-conditioning of the library with financial assistance given by the Ministry of Environment and Forests, Government of India, is in progress. With this, the preservation of valuable books and manuscripts in the library is now assured.

## CONSERVATION

The Society was consulted by the Govt. of India and other organisations and by members of the Society on various matters of conservation interest. The Society's representatives on various conservation committees and organisations offer ther expertise available at the Society.

The proposal to construct major dams on the Narmada River and the clearance of the proposal by the Government of India for funding was a cause for acute concern. The Committee consulted other like minded organisations and persons on a possible positive approach to prevent environmental damage.

## SALIM ALI CENTRE FOR ORNITHOLOGY AND NATURAL HISTORY

We are glad to report that the proposal has been re- activated and the scope of the Centre enhanced by the addition of "Natural History" to its terms of reference. Negotiations have been finalised and the sanction order has been received and funds released for preliminary expenses. We should be registering the new society and commencing operations in 1989.

## DONATIONS

We are grateful to the Ministry of Environment and Forests for a grant to purchase an Atomic Absorption Spectrophotometer for the Bharatpur Field Project and a photo copier for the Library.

We are grateful to the many organisations and persons for donations to the Society.

| | | |
|---|---|---|
| 1. | General Donations Received from Members | 27,315 |
| 2. | **Charles McCann Vertebrate Zoology Field Work Fund** | |
| | Mr S Chaudhury | 750 |
| 3. | **Dr Salim Ali Memorial Fund** | |
| | Mrs Kumud N Pandit | 100 |
| | M/s Row Dayal Trust | 500 |
| | Mr George Jonkel | 2,000 |
| | Col. Guru Ratam Singh | 1,000 |
| | M/s Tata Chemical Terminal | 10,000 |
| | Ms Rajeshree Gokhaldas | 5,000 |
| | Total | **18,600** |
| 4. | **Salim Ali Nature Conservation Fund** | |
| | M/s Cheng Kim Loke Foundation | 4,00,000 |
| | M/s Cheng Kim Loke Foundation | 35,000 |
| | Lady Peng McNiece C/o | 2,00,000 |
| | Total | **6,35,000** |
| 5. | **Donations for Dang Forest Survey & Hornbill Newsletter** | |
| | Seth Purshotamdas Thakurdas | |
| | Divaliba Charitable Trust | |
| | For Dang Survey | 30,000 |
| | For Hornbill Newsletter | 25,000 |

## ACKNOWLEDGEMENTS

The Executive Committee acknowledges with thanks the assistance given to BNHS by the Department of Environment, Forests and Wildlife and the Ministry of Defence of Goverment of India, the US Fish & Wildlife Service, the Government of Maharashtra, and the Charity Commissioner, Bombay. It also thanks the various donors, the members and staff of the BNHS for their unstinting cooperation in the various activities of the BNHS.

A.N.D.Nanavati, M.D.
Honorary Secretary

## HONORARY TREASURER'S REPORT ON THE ACCOUNTS FOR THE 15 MONTH PERIOD ENDING 31 MARCH 1989

1) The "Annual" Accounts for 1988–1989 relate to an extended period of 15 months and this has to be kept in mind when comparing the results with those of the previous year (1987). However, it must be noted that income by way of dividends, Grant from the Govt. of Maharashtra, and from sales of books, calendars and greeting cards is on an annual or six-monthly basis, and so these receipts did not increase corresponding to the 15-month period. Taking all aspects into account, the results of 1988-1989 may be considered encouraging.

2) During the period, the total funds owned by the Society went up by about Rs 21.98 lakhs, as follows:

| | |
|---|---|
| (i) Increase in Life Membership Fund | Rs. 2.78 lakhs |
| (ii) Increase in Corpus Funds (Schedule A) | Rs. 6.65 lakhs |
| (iii) Increase in Other Funds (Schedule B) | Rs. 11.22 lakhs |
| (iv) Excess of income over expenditure | Rs 1.33 lakhs |

The increase of Rs 12.55 lakhs under items (iii) and (iv) may be considered a fair measure of the working of 1988-1989. The corresponding figure for the previous year was Rs 5.5 lakhs.

3) Income from the following items showed significant increases: interest, dividends, administrative fees and sales of books. At the same time, there were large increases in the expenses on Establishment (45%), the Journal and the Hornbill. There was also a decrease in the surplus from sales of greeting cards, which was partly offset by an improvement in the sales of nature calendars.

4) The five research Projects funded by the US Fish and Wildlife Service and the Bird Hazard Project funded by the Govt. of India, have played vital role in building up the Society's resources of men, materials and money. It will be seen that administrative fees for handling Project funds make a large contribution to our annual revenues. However, the Accounts do not give an indication of the assets given on loan for these Projects, such as computer systems, laboratory equipments, vehicles and so on. The original costs of these assets, many of which may be donated to the Society on the conclusion of the Projects, add up to about Rs 28 lakhs.

5) While the results of 1988-1989 show an improvement, there is little scope for complacency in regard to the finances of the Society. Establishment costs and expenses in regard to our traditional activities continue to rise inexorably due to inflation. It is also necessary to strengthen our administration and certain new posts have been created for that purpose. This, however, is a move that should, in due course, more than pay for itself by improved efficiency in operations. Further, as the current research Projects come to an end, new Projects will have to be developed if receipts by way of administrative charges are to be maintained at present levels.

6) In the final analysis, the real challenge is to build up our own financial resources in order to progressively increase our regular income and also to meet the growing requirements of working capital.

14 October 1989
Bombay

Pratap Saraiya
Honorary Treasurer

## AUDITOR'S REPORT

*Re: BOMBAY NATURAL HISTORY SOCIETY*
*[Registration No.F-244 (Bom)]*

We have audited the attached Balance Sheet of the Society as at 31st March, 1989 and also the annexed Income & Expenditure Account for the financial year ended on that date and report that in our opinion and to the best of information and explanation given to us:

(a) the accounts are maintained regularly and in accordance with the provisions of the Bombay Public Trust Act, 1950 subject to the observation that as per past practice separate Receipts & Payments Accounts has been drawn for the Nature Education Scheme, and the same has not been incorporated in the accounts of the Society. We also observe that during the year the Society did not receive the annual grant from the Govt. of Maharashtra for the year 1988-89 towards establishment and building maintenance and for the publication of the Journal (educational activity) and no sanction letters too having been received, the said grants could not be recognised as income. The relevant expenses have therefore been charged to Income & Expenditure account,

(b) the receipts and disbursements have been properly and correctly shown in the accounts,

(c) the cash balance and the vouchers in the custody of the accountant on the date of audit were in agreement with the books of accounts,

(d) the books, deeds, accounts, vouchers and/or other documents or records required by us were produced to us,

(e) the register of movable and immovable properties is properly maintained and the changes therein have been communicated to the Regional Office,

(f) the accountant appeared before us and furnished the necessary information required by us,

(g) we are not aware of any property or funds of the Society having been applied for any objects or purpose other than the objects of the Society,

(h) the following items were outstanding for more than one year:

| | |
|---|---|
| (i) Due towards supplies and services | Rs. 3,193.00 |
| (ii) Income tax Recoverable | Rs. 840.00 |
| (iii) Loan to staff (since recovered) | Rs. 800.00 |

We may add that the outstanding against supplies and services interalia include certain items, which are outstanding since 1986. We have been assured that the outstanding balances are considered good and realisable. We may nonetheless suggest that effective measures be taken to realise the outstanding. During the financial year under report a sum of Rs.1,067.07 representing dues considered irrecoverable has been written off,

(i) during the financial year there were no repairs or construction carried out to the property in the occupation of the Society involving expenditure exceeding Rs.5,000,

(j) we are not aware of any money of the Society having been invested in contravention of Sec.35 of the Bombay Public Trust Act, 1950,

(k) we are not aware of any immovable property of the Society, therefore, the question of alienation of any property contrary to the provisions of Sec.36 of the Bombay Public Trust Act, 1950 does not arise,

(1) (i) in regard to the expenses charged to various grants and funds, we have relied on the information given to us and the authentication of the Hon.Secretary and Hon.Treasurer that the expenses so charged relate to these grants and have been spent on the specific objects for which the grants were received. While checking the statement of accounts in regard to the expenditure incurred at various camps, we have relied on the authorisation by the Hon.Secretary and Hon.Treasurer as to the reasonableness of the expenditure,

(ii) the income towards membership subscription is being accounted on realisation basis,

(iii) the subscriptions received in foreign currency, we observe, are deposited in an account maintained with Grindlays Bank Plc., London Branch. The said receipts and disbursements made therefrom have been accounted at the exchange rate prevailing at the date of the Balance Sheet. The closing balance has been translated at the current exchange rate, at the date of the Balance Sheet and the difference in exchange amounting to Rs.6,168.62 has been credited to Income & Expenditure account,

(iv) we suggest the following items of disbursement effected, provisions made, administrative charges levied and amount written off be confirmed and ratified at the next meeting of the Executive Committee :

## A. Disbursement from:

| | | *Rs.* |
|---|---|---|
| (i) | Interest on Col. Burtons Nature Conservation Fund | 24.38 |
| (ii) | Chas McCann Vertebrate ZoologyField Work Fund | 613.20 |
| (iii) | Interest on Salim Ali/Loke Wan Tho Ornithology Research Fund Investment | 28,557.62 |
| (iv) | Interest on Salim Ali Nàture Conser-vation Fund Investment | 1,80,961.37 |
| (v) | Interst on Pirojsha Godrej FoundationField Work Fund Investment | 9,761.70 |
| (vi) | Dorabjee Tata Trust Field Work Fund | 3,000.00 |
| (vii) | Plant Study Fund | 11,618.05 |
| (viii) | Field Study and Schlolarship Fund from Watanmal Boolchand Charitable Trust | 5,824.00 |
| (xi) | Grant from Government of Maharashtra for 1987-88 towards establishment,Building Maintenance and Educational Activity, (i.e. Journal Printing exp.) | 2,15,000.00 |
| (x) | Govt. of India A.R.D.B. Grant for Bird Hazard Research Cell | 87,044.74 |
| (xi) | Govt. of India A.R.D.B. Grant for ecological reliance of Whitebacked Vulture | 40,808.05 |
| (xii) | R.G. Saraiya Research Grant | 25,000.00 |
| (xiii) | Chako Fund | 10,000.00 |
| (xiv) | Grant from U.S. Department of Interior Fish and Wildlife Service for : | |
| | (a) Study of Lesser Bustard (Florican) | 6,82,789.10 |
| | (b) Ecology of Keoladeo National Park, Bharatpur | 24,04,695.30 |
| | (c) Ecology of Point Calimere Sanctuary | 7,04,155.63 |
| | (d) Ecology of Indian Elephants | 11,98,647.06 |
| | (e) Study of Migration Pattern of Indian Birds and Avifauna Migration Data Bank | 13,40,131.19 |
| | (f) For the project on the habitat and population dynamics of Wolves and Blackbucks | 1,40,747.00 |
| (xv) | Grant Indian National Science Academy for the publication of Journal | 5,000.00 |
| (xvi) | Grant Chief Wildlife Warden, Jammu & Kashmir for the project on Survey of Blacknecked Crane | 5,526.90 |
| (xvii) | Grant Govt. of India (DST) towards Dr. Salim Ali Centre for Ornithology and Natural History | 4,712.00 |

## B. Appropriations:

| | | |
|---|---|---|
| (i) | Govt. Publication Fund, sale proceeds of publication | 3,48,206.37 |
| (ii) | Fixed Assets Fund towards depreciation on Fixed Assets | 51,892.52 |
| (iii) | Amount written off | 1,067.07 |
| (iv) | Administrative fees charged to various Grants/Funds for handling the projects. etc. | 8,93,760.61 |
| (v) | Addition to fixed assets (other than those charged to various projects) | 1,15,830.00 |

(m) so far as is ascertainable from the books of accounts and according to the information and explanation furnished to us by the accountant and the Hon.Secretary,there were no cases of irregular, illegal or improper expenditure or failure to recover the monies or other properties belonging to the Society or loss or waste of money or other property of the Society, subject to the observation made in para (h) hereinabove,

(n) provision of Sec. 31-A and Rule 16-A of the Bombay Public Trust Act, 1950 have been complied with.

II. (a) the maximum and minimum number of Executive Committee members is maintained having regard to the provision contained in the rules and regulations,

(b) there is no specific provisions in the rules and regulations of the Society regarding the holding of the meetings of the Executive Committee,

(c) the minute book recording the proceedings of the meetings is maintained,

(d) no member of the Executive Committee has any interest in the investment of the Society,

(e) no member of the Executive Committee is a debtor or a creditor of the Society.

*Bombay*
*Dated: 15 September 1989*

CHARTERED ACCOUNTANTS

REGD.NO.F-244(BOM)

# BOMBAY NATURAL HISTORY SOCIETY

BOMBAY PUBLIC TRUST ACT 1950
Schedule VIII vide Rule 17(1)
BALANCE SHEET AS AT 31st MARCH, 1989

| FUNDS AND LIABILITIES | Rs. | Rs. | ASSETS | Rs. | Rs. |
|---|---|---|---|---|---|
| **FUNDS AND LIABILITIES** | | | **IMMOVABLE PROPERTIES** | | |
| Life Membership Fund (individual) | | | | | |
| Balance as per last Balance Sheet | 7,89,449.86 | | **INVESTMENTS (at appropriate value)** | | |
| ADD: Amount received during the year | 2,77,673.25 | 10,67,123.11 | Government Securities (at cost) | | |
| Corporate Life Membership Fund | | | 5.5% Govt. of India Loan 2000 of the face value of Rs.2000/- (Market Value Rs. 1,211.00) | 2,000.00 | |
| Balance as per last Balance Sheet | | 2,15,742.31 | | | |
| Vice Patron Fees | | | | | |
| Balance as per last Balance Sheet | | 42,769.00 | | | |
| **CORPUS FUNDS** | | | | | |
| As per Schedule 'A' | | 17,57,691.48 | 4249.976 Units of the Unit Trust of India under reinvestment plan of the face value of Rs.100/- each (Total face value Rs.4, 24,997.60 including accumulated dividend units 2249.976 | 4,36680.27 | |
| **OTHER FUNDS** | | | | | |
| As per Schedule 'B' | | 45,41,186.50 | | | |
| **LIABILITIES** | | | 70,150 Units of the Unit Trust of India each of the face value of Rs.100/-. (Total face value Rs.7,01,500/-). Unit Scheme 1964 repurchase value Rs.7,85,680/- | 9,99,637.50 | |
| Unspent Grant as per Schedule 'C' | 29,04,394.44 | | | | |
| For Expenses | 1,63,564.59 | | **FIXED DEPOSITS WITH** | | |
| For Library deposits | 2,550.00 | | i) M/s. Bharat Petroleum Corporation Ltd. | 5,00,000.00 | |
| For Sundry Credit balances | 21,422.00 | | | | |
| For Advance for Publications | 11,044.92 | | | | |
| For Advance for Nature Camps | 20,191.00 | 31,23,166.95 | ii) Housing Development Finance Corporation Ltd | 20,00,000.00 | 39,38,317.77 |
| Carried over | | 1,07,47,679.35 | Carried over | | 39,38,317.77 |

| FUNDS AND LIABILITIES | | | ASSETS | | |
|---|---|---|---|---|---|
| | *Rs.* | *Rs.* | | *Rs.* | *Rs.* |
| Brought over | | 1,07,47,679.35 | Brought over | | 39,38,317.77 |
| **OTHER ADVANCES** | | | **MOTOR CARS, MOTOR CYCLE, AUTO CYCLE AND MINI BUS** | | |
| Amount received for and on behalf of the proposed Institute | | | Balance as per last Balance Sheet | 83,829.07 | |
| Balance as per Last Balance sheet | 2,60,978.91 | | **Less:** Depreciation during the year | 20,118.96 | 63,710.11 |
| **Add:** Interest credited during the year | 25,000.00 | | **FURNITURE, FIXTURE AND EQUIPMENT** | | |
| | 2,85,978.91 | | Balance as per last Balance sheet | 94,654.76 | |
| | | | **Add:** Additions during the year | 1,15,830.00 | |
| | | | | 2,10,484.76 | |
| **Less:** Expenditure for and on account of the Institute incurred during the year | 16,234.75 | 2,69,744.16 | **Less:** Depreciation during the year | 31,773.56 | 1,78,711.20 |
| | | | **LOANS (Unsecured considered good)** | | |
| | | | To employees | | 30,148.00 |
| | | | **ADVANCES (Unsecured considered good)** | | |
| **INCOME AND EXPENDITURE ACCOUNT** | | | To Trustees | — | |
| | | | To Employees for Project Expenses | 3,18,722.83 | |
| | | | To Employes for Society's Exp. | 7,471.75 | |
| | | | To Others | 32,589.95 | |
| Excess of Income over expenditure transferred from Income and Expenditure Account during the year | 1,32,585.97 | | To Nature Education Scheme | 49,214.47 | |
| **Less:** Deficit as per last Balance Sheet | 1,16,033.20 | 16,552.77 | To deposit with Telephone Nigam Ltd. | 8,000.00 | |
| | | | Marginal money with Corporation Bank for Letter of Credit for the import of equipments for projects | 95,495.00 | 5,11,494.00 |
| Carried over | | 1,10,33,976.28 | Carried over | | 47,22,381.08 |

| FUNDS AND LIABILITIES | | | ASSETS | | |
|---|---|---|---|---|---|
| | *Rs.* | *Rs.* | | *Rs.* | *Rs.* |
| Brought over | | 1,10,33,976.28 | Brought over | | 47,22,381.08 |
| | | | **STOCKS** | | |
| | | | A) Publication under BNHS Funds as per inventory taken and certified by the Honorary Secretary at or below cost | 5,37,180.74 | |
| | | | B) Publication under Govt. of India funds as per inventory taken and certified by the Honorary Secretary at or below cost | 80,317.84 | |
| | | | C) Safety Cartridges (as certified by the Honorary Secretary) | 9,530.35 | |
| | | | D) Publications (under preparation). Expenses incurred till date | | |
| | | | i) Book of Indian Trees | 23,126.90 | |
| | | | ii) Encyclopaedia of Indian Natural History 2nd Edition | 59,571.52 | 7,09,727.35 |
| | | | **INCOME OUTSTANDING** | | |
| | | | Interest Accrued | 1,04,382.06 | |
| | | | Supplies and Services (bills receivable) | | |
| | | | i) Publications & Calendars | 26,107.25 | |
| | | | ii) Greeting Cards | 53,703.85 | |
| | | | Grant Govt. of Maharashtra for Establishment, Building Maintenance, Education Activity (Journal Printing) and Nature Study Teaching Scheme 1987-88 | 2,15,000.00 | |
| | | | | 3,99,193.16 | |
| Brought over | | 1,10,33,976.28 | Carried over | | 54,32,108.43 |

| FUNDS AND LIABILITIES | *Rs.* | *Rs.* | ASSETS | *Rs.* | *Rs.* |
|---|---|---|---|---|---|
| Brought over | | 1,10,33,976.28 | Brought over | | 54,32,108.43 |
| | | | **INCOME OUTSTANDING (Contd..)** | 3,99,193.16 | |
| | | | Grant U.S. Fish and Wildlife Services for the Projects (Advanced by BNHS) as per Schedule 'C' | 7,91,814.00 | 11,91,007.16 |
| | | | **INCOME TAX REFUNDABLE** | | 840.00 |
| | | | Cash and Bank Balances as per Schedule 'D' including Rs. 28,49,583.34 in fixed deposits 44,10,020.69 | 44,10,020.69 | |
| TOTAL RUPEES | | 1,10,33,976.28 | TOTAL RUPEES | | 1,10,33,976.28 |

BOMBAY NATURAL HISTORY SOCIETY

HON.SECRETARY HON.TREASURER
TRUSTEE

AS PER OUR REPORT OF EVEN DATE

HABIB AND COMPANY
CHARTERED ACCOUNTANT
BOMBAY

Bombay
Dated : 15 September 1989

## BOMBAY NATURAL HISTORY SOCIETY

## SCHEDULE FORMING PART OF BALANCE SHEET AS ON 31ST MARCH 1989

SCHEDULE ‘A’

| Name of the Corpus Funds | Balance as per last balance sheet | Amount Received/ appropriated during the year | Total of columns 1 & 2 | Balance as on 31-03-1989 |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| | Rs. | Rs | .Rs. | Rs. |
| Salim Ali/Loke Wan Tho Ornithological Research Fund | 3,73,136.52 | * 30,000.00 | 4,03,136.52 | 4,03,136.52 |
| Salim Ali Nature Conservation Fund | 6,76,554.96 | 6,35,000.00 | 13,11,554.96 | 13,11,554.96 |
| Col. Burtons Nature Conservation Fund | 3,000.00 | — | 3,000.00 | 3,000.00 |
| Pirojsha Godrej Foundation Fieldwork Fund | 40,000.00 | — | 40,000.00 | 40,000.00 |
| | 10,92,691.48 | 6,65,000.00 | 17,57,691.48 | 17,57,691.48 |

*Transferred from interest on Salim Ali Lok Wan Tho Ornithological Research Fund as per Schedule ‘B’.

## BOMBAY NATURAL HISTORY SOCIETY

## SCHEDULE FORMING PART OF BALANCE SHEET AS ON 31ST MARCH 1989

**SCHEDULE 'B'**

| NAME OF THE OTHER FUNDS | Balance as per last balance sheet | Amount recd./ appropriated during the year | Interest credited during the year | Total of columns 1, 2 & 3 | Transferred to income & expenditure account during the year | Expenditure on objects of the trust as shown in Income & Exp. account | Transferred to other funds during the year | Balance as on 31-3-89 |
|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| | *Rs.* | *Rs.* | *Rs.* | *Rs.* | *Rs.* | *Rs.* | *Rs.* | *Rs.* |
| Staff Welfare Fund | 36,322.84 | — | — | 36,322.84 | — | — | — | 36,322.84 |
| Interest on Col.Burtons Nature Fund Investment | 610.33 | — | 375.33 | 985.00 | 24.38 | 24.38 | — | 960.95 |
| Charles McCann Vertebrate Zoology Field Work Fund | 70,537.27 | 750.00 | 8,994.13 | 80,281.40 | 613.20 | 613.20 | — | 79,668.20 |
| Interest on Salim Ali Lok Wan Tho Ornithological Researh Fund Investment | 81,106.77 | — | 47,392.06 | 1,28,498.83 | 28,557.62 | 28,557.62 | 30,000.00 | 69,941.21 |
| Interest on Salim Ali Nature Conservation Fund Investment | 2,08,446.63 | — | 1,34,361.02 | 3,42,807.65 | 1,80,961.37 | 1,80,961.37 | * 3,415.00 | 1,58,431.28 |
| Interest on Field Fund under Pirojsha Godrej Foundation Fund Investment | 5,742.95 | — | 5,000.00 | 10,742.95 | 9,761.70 | 9,761.70 | — | 981.25 |
| Field Work Fund Sir Dorabjee Tata Trust | 8,149.20 | — | — | 8,149.20 | 3,000.00 | 3,000.00 | — | 5,149.20 |
| Field Study and Scholarship Fund from Watanmal Boolchand Charitable Trust | 7,565.85 | — | — | 7,565.85 | 5,824.00 | 5,824.00 | — | 1,741.85 |

## SCHEDULE ’B’ (Contd..)

| NAME OF THE OTHER FUNDS | Balance as per last balance sheet | Amount recd./ appropriated during the year | Interest credited during the year | Total of columns 1, 2 & 3 | Transferred to income & expenditure account during the year | Expenditure on objects of the trust as shown in Income & Exp. account | Transferred to other funds during the year | Balance as on 31-3-89 |
|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| | *Rs* | *Rs* | *Rs.* | *Rs.* | *Rs.* | *Rs.* | *Rs.* | *Rs.* |
| Brought over | 4,18,481.84 | 750.00 | 1,96,122,21 | 6,15,354.05 | 2,28,742.27 | 2,28,742.27 | 33,415.00 | 3,53,196.78 |
| Photography Exhibition Fund received from Shri M Y Ghorpade of Sandur | 10,0000 | — | — | 10,000.00 | — | — | — | 10,000.00 |
| Plant Study Fund | 93,959.25 | — | — | 93,959.25 | 11,618.05 | 11,618.05 | — | 82.341.20 |
| Education & Research Fund created out of Income | 9,33,698.36 | — | — | 9,33,698.36 | — | — | *8,00,000.00 | 1,33,698.36 |
| Donation from Seth Purushottamdas Thakoredas & Divaliba Charitable Trust for the R.G. Saraiya Research Grant | 25,000.00 | — | — | 25,000.00 | 25,000.00 | 25,000.00 | — | — |
| Fixed Assets Fund | 1,08,434.1 | *1,13,415.00- | — | 2,21,849.11 | 51,892.52 | 51,892.52 | — | 1,69,956.59 |
| Building Fund | 1,03,227.68 | — | — | 1.03,227.68 | — | — | — | 1,03,227.68 |
| General Reserve Fund | 2,07,624.02 | 1,00,000.00 | — | 3,07,624.02 | — | — | — | 3,07,624.02 |
| Staff Gratuity Fund | 3,38,935.28 | 2,00,000.00 | 42,730.24 | 5,81,665.52 | 19,359.60 | 19,359.60 | — | 5,62,305.92 |
| Chacko Fund for Education & Conservation | 47,559.70 | — | — | 47,559.70 | 10,000.00 | 10,000.00 | — | 37,559.70 |
| Salim Ali Memorial Fund (including *Rs.8,00,000/= transferred from Education & Research Fund | 1,21,250.91 | 12,18,600.00 | — | 13,39,850.91 | — | — | — | 13,39,850.91 |
| | 24,08,171.15 | 16,32,765.00 | 2,38,852.45 | 42,79,788.60 | 3,46,612.44 | 3,46,612.44 | 8,33,415.00 | 30,99,761.16 |

## SCHEDULE 'B' (Contd..)

| NAME OF THE OTHER FUNDS | Balance as per last balance sheet | Amount recd./ appropriated during the year | Interest credited during the year | Total of columns 1, 2 & 3 | Transferred to income & expenditure account during the year | Expenditure on objects of the trus as shown in Income & Exp. account | Transferred to other funds during the year | Balance as on 31-3-89 |
|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| | *Rs.* | *Rs.* | *Rs.* | *Rs.* | *Rs.* | *Rs.* | *Rs.* | *Rs.* |
| Brought over | 24,08,171.15 | 16,32,765.00 | 2,38,852.45 | 42,79,788.60 | 3,46,612.44 | 3,46,612.44 | 8,33,415.00 | 30,99,761.16 |
| Publication Fund BNHS | 8,84,317.36 | 82,471.40 | — | 9,66,788.76 | — | — | — | 9,66,788.76 |
| Publication Fund from Govt. of India DST | | | | | | | | |
| 1) Sale proceeds of Century of Natural History 20104.42 | | | | | | | | |
| 2) Sale proceeds of Book of Indian Reptiles 46101.95 | | | | | | | | |
| 3) Encyclopedia of Indian Natural History 282000.00 | | | | | | | | |
| | 1,26,430.21 | 3,48,206.37 | — | 4,74,636.58 | — | — | — | 4,74,636.58 |
| TOTAL RUPEES | 34,18,918.72 | 20,63,442.77 | 2,38,852.45 | 57,21,213.94 | 3,46,612.44 | *3,46,612.44 | 8,33,415.00 | 45,41,186.50 |

| | Rs. |
|---|---|
| towards Dang Forest Survey | 30,000.00 |
| towards Nature Education Scheme | 30,000.00 |
| towards Studies on Natural History | 29,081.00 |
| towards depreciation on fixed assets | 51,892.52 |
| towards staff gratuity | 19,359.60 |
| towards other educational objects | 1,86,279.32 |
| * Rs | 3,46,612.44 |

# BOMBAY NATURAL HISTORY SOCIETY
## SCHEDULE FORMING PART OF BALANCE SHEET AS ON 31ST MARCH 1989

**SCHEDULE 'C'**

| Name of Grants/ Advances | Unspent/ over spent balance as per last Balance Sheet 1 | Amount received/ appropri-ted during the year 2 | Amount received/ as advance from the Society (BNHS) 3 | Total of columns 1, 2 & 3 4 | Income for the year as credited to Income & Expenditure account 5 | Expenditure on objects of the Trust as shown in Income & Exp. account 6 | Unspent grant refunded to Govt. during the year 7 | Unspent Balance carried to next year 8 |
|---|---|---|---|---|---|---|---|---|
| | Rs. | Rs. | Rs. | Rs. | Rs. | Rs. | Rs. | Rs. |
| Grant Govt. of India, Ministry of Defence, ARDB for Bird Hazard Research Cell | 78,938.75 | — | 8,105.99 | 87,044.74 | 87,044.74 | 87,044.74 | — | Nil |
| Grant Govt. of India, Ministry of Defence, ARDB for Ecological Relevance of White-backed Vulture - The major bird strike hazard to military aircrafats in India | 40,808.05 | — | — | 40,808.05 | 40,808.05 | 40,808.05 | — | Nil |
| **Grants from** U.S.Department of Interior, Fish and Wildlife Service - Natural Park Service | | | | | | | | |
| 1) Hydrological (Ecological) Research Station at Keoladeo Ghana Sanctuary, Bharatpur | 7,617.47 | — | — | 7,617.47 | — | — | — | 7,617.47 |
| 2) Study of Lesser Bustard (Florican) *Sypheotides indica* and the Bengal Florican *Houbaropsis bengalensis* | 1,40,510.85 | 3,68,975.00 | 1,73,303.25 | 6,82,789.10 | 6,82,789.10 | 6,82,789.10 | — | Nil |
| Carried over | 2,67,875.12 | 3,68,975.00 | 1,81,409.24 | 8,18,259.36 | 8,10,641.89 | 8,10,641.89 | — | 7,617.47 |

## SCHEDULE 'C' (Cont..)

| Name of Grants/ Advances | Unspent/ over spent balance as per last Balance Sheet 1 | Amount received/ appropri-ted during the year 2 | Amount received/ as advance from the Society (BNHS) 3 | Total of columns 1, 2 & 3 4 | Income for the year as credited to Income & Expenditure account 5 | Expenditure on objects of the Trust as shown in Income & Exp. account 6 | Unspent grant refunded to Govt. during the year 7 | Unspent Balance carried to next year 8 |
|---|---|---|---|---|---|---|---|---|
| | Rs. | Rs. | Rs. | Rs. | Rs. | Rs. | Rs. | Rs. |
| Brought over | 2,67,875.12 | 3,68,975.00 | 1,81,409.24 | 8,18,259.36 | 8,10,641.89 | 8,10,641.89 | — | 7,617.47 |
| 3) Ecology of Keoladeo Ghana National Park, Bharatpur | 17,94,290.54 | — | 6,10,404.76 | 24,04,695.30 | 24,04,695.30 | 24,04,695.30 | — | Nil |
| 4) Ecology of Indian Elephant | 13,10,065.11 | — | — | 13,10,065.11 | 11,98,647.06 | 11,98,647.06 | — | 1,11,418.05 |
| 5) The Ecology of Pt. Calimere Sanctuary (An Endangered Ecosystem) | 8,66,186.27 | — | — | 8,66,186.27 | 7,04,155.63 | 7,04,155.63 | — | 1,62,030.64 |
| 6) Study of the Migration pattern of Indian Birds and Avifauna Migration Study Data Bank | 13,89,092.25- | — | — | 13,89,092.25 | 13,40,131.19 | 13,40,131.19 | — | 48,961.06 |
| Grant Govt. of India D.O.E. for the expenses on secretarial assistance to Dr Salim Alim for environmental research programme for processing archieval material | 21,453.38 | — | — | 21,453.38 | — | — | — | 21,453.38 |
| Grant Govt. of India, Dept. of Culture, for publishing the Centenary Seminar papers of the Society 1984-85 continued till 1988-89 | 29,657.45 | — | — | 29,657.45 | — | — | — | 29,657.45 |
| Carried over | 56,78,620.12 | 3,68,975.00 | 7,91,814.00 | 68,39,409.12 | 64,58,271.07 | 64,58,271.07 | — | 3,81,138.05 |

## SCHEDULE ‘C’ (Cont..)

| Name of Grants/ Advances | Unspent/ over spent balance as per last Balance Sheet | Amount received/ approprited during the year | Amount received/ as advance from the Society (BNHS) | Total of columns 1, 2 & 3 | Income for the year as credited to Income & Expenditure account | Expenditure on objects of the Trust as shown in Income & Exp. account | Unspent grant refunded to Govt. during the year | Unspent Balance carried to next year |
|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| | *Rs.* | *Rs.* | *Rs.* | *Rs.* | *Rs* | *Rs.* | *Rs.* | *Rs.* |
| Brought over | 56,78,620.12 | 3,68,975.00 | 7,91,814.00 | 68,39,409.12 | 64,58,271.07 | 64,58,271.07 | — | 3,81,138.05 |
| Grant Govt. of India, D.O.E. for air conditioning the Hornbill House, Library and Collection Rooms | 8,14,150.00 | — | — | 8,14,150.00 | — | — | — | 8,14,150.00 |
| Grant Govt. of India, D.O.E. for the purchase of scientific equipment during 1988–89 | — | 7,00,000.00 | — | 7,00,000.00 | *1,10,000.00 | *1,10,000.00 | — | 5,90,000.00 |
| Grant from Chief Wildlife Warden, Jammu & Kashmir for the projection survey of Blacknecked Crane | 44,292.29 | — | — | 44,292.29 | 5,526.90 | 5,526.90 | — | 38,765.39 |
| Grant Govt. of Maharashtra for building repairs for 1984-85 contd. till 1987-88 | 74,514.76 | — | — | 74,514.76 | — | — | 74,514.76 | — |
| U.S. Dept. of Interior Fish and Wildlife Service, National Park, for the project on Wolves and Blackbucks (the habitat and population dynbamics of Wolves and blackbucks) | — | 2,25,800.00 | — | 2,25,800.00 | 1,40,747.00 | 1,40,747.00 | — | 85,053.00 |
| Grant Govt. of India, Ministry of Environment, Forests and Wildlife towards Salim Ali Centre for Ornithology and Natural History | — | 10,00,000.00 | — | 10,00,000.00 | 4,712.00 | 4,712.00 | — | 9,95,288.00 |
| TOTAL RUPEES | 66,11,577.17 | 22,94,775.00 | 7,91,814.00 | 96,98,166.17 | 67,19,256.97 | 67,19,256.97 | 74,514.76 | 29,04,394.44 |

*transferred to fixed assets fund on utilisation for purchase of xerox machine

## BOMBAY NATURAL HISTORY SOCIETY
## SCHEDULE FORMING PART OF BALANCE SHEET AS AT 31ST MARCH 1989

### SCHEDULE 'D'

| CASH AND BANK BALANCES | Rs. | Rs. |
|---|---|---|
| **A) In Current Account with:** | | |
| i) Grindlays Bank Plc, M.G.Road, Bombay 400 023 | 3,62,128.87 | |
| ii) Grindlays Bank, Plc, London (£ 5635.68) | 1,40,892.00 | |
| iii) Standard Chartered Bank, M.G.Road, Bombay 400 023 | 4,257.91 | |
| | | 5,07,278.78 |
| **In Savings Account with:** | | |
| iv) Grindlays Bank Plc, M.G.Road, Bombay 400 023 | 5,84,496.21 | |
| v) Bank of India, Museum Savings Br., Bombay 400 023 | 83,772.96 | |
| vi) Bank of Baroda, University Br., M.G.Road, Bombay 400 023 | 1,55,134.36 | |
| vii) Corporation Bank, Dalal Street Br., Bombay 400 023 | 1,89,219.95 | |
| –do– (FERA) | 1,000.00 | |
| vii) Grindlays Bank Plc, M.G.Road, Bombay 400 023, for Salim Ali Memorial Fund | 39,535.09 | |
| | | 10,53,158.57 |
| **B) Fixed Deposit with :** | | |
| i) Bank of India M.G.Road, Bombay 400 023 | 1,19,583.34 | |
| ii) Standard Chartered Bank M.G.Road, Bombay 400 023 | 1,00,000.00 | |
| iii) Bank of Baroda, Univeristy Br., M.G.Road, Bombay 400 023 | 1,00,000,00 | |
| iv) Corporation Bank, Dalal Street, Bombay 400 023 | 16,00,000.00 | |
| v) Grindlays Bank Plc, M G Road, Bombay 400 023 | 1,55,000.00 | |
| C) In Monthly Income Certificate with: | | |
| Bank of India,M.G. Road, Bombay 400 023 | 7,75,000.00 | |
| | | 28,49,583.34 |
| TOTAL RUPEES | | 44,10,020.69 |

REGD.NO.F-244(BOM)

## BOMBAY NATURAL HISTORY SOCIETY

*BOMBAY PUBLIC TRUST ACT 1950*
*Schedule IX vide Rule 17(1)*

## INCOME AND EXPENDITURE ACCOUNT FOR THE PERIOD 1ST JANUARY 1988 TO 31ST MARCH 1989

| EXPENDITURE | Rs. | Rs. |
|---|---|---|
| **EXPENSES IN RESPECT OF PROPERTIES** | | |
| Rates and Taxes | 4,826.00 | |
| Insurance (on Building) | 266.00 | |
| **OTHER CONTINGENCY EXPENSES** | | |
| Contingency expenses, Electricity Charges and Building Maintenance | 38,520.85 | 43,612.85 |
| **ESTABLISHMENT EXPENSES** | | |
| A) Salaries including D.A, H.R.A, etc. for Reference Collection staff for the period : | | |
| i) 1–1–1988 to 31–03–88 | 47,622.00 | |
| i) 1–4–1988 to 31–12–88 | 1,86,324.00 | |
| ii) 1–1–1989 to 31–03-89 | 60,434.00 | |
| A) Salaries including D.A, H.R.A, etc. other than above (excluding Rs. 29,081.00 &Rs. 32,919.00 for Plant Study staff and Conservation staff | 8,89,821.60 | |
| Gratuity payment to staff members | 19,359.60 | |
| Wages (Casual Labour) | 3,315.00 | |
| Leave Travel expenses to staff members | 15,615.80 | |
| Medical Expenses to staff members | 9,478.00 | |
| Society's Contribution to staff Providend Fund | 19,772.00 | |
| Postages | 27,251.60 | |
| Legal fees | 850.00 | |
| Printing & Stationary | 50,921.08 | |
| | 13,30,764.68 | |
| Carried over | | 43,612.85 |

| INCOME | Rs. | Rs |
|---|---|---|
| **RENT** | | |
| Interest (Realised & Accrued) | | |
| On Securities | 137.50 | |
| On Fixed Deposits and Bank account (including Rs.2,63,852.45 on earmarked funds) | 8,18,707.95 | 8,18,845.45 |
| **DIVIDEND** | | |
| On Units of the Unit Trust of India | | 1,70,901.98 |
| **DONATIONS (in cash or kind)** | | |
| i) General Donations | 27,315.75 | |
| ii) For specific donations: | | |
| a) Charles McCann Vertebrate zoology Field Work Fund | 750.00 | |
| b) Salim Ali Memorial Fund | 18,600.00 | |
| c) Salim Ali Nature Conservation Fund | 6,35,000.00 | |
| d) Dang Forest Survey expenses from Purushottamdas Thakurdas & Divaliba Charitable Trust | 30,000.00 | |
| e) Donations from Seth Purushottamdas Thakoredas & for Hornbill Newslette | 25,000.00 | |
| | 7,36,665.75 | |
| Carried over | | 9,89,747.43 |

| EXPENDITURE | Rs. | Rs. |
|---|---|---|
| Brought over | | 43,612.85 |
| **ESTABLISHMENT EXPENSES (Contd..)** | 13,30,764.68 | |
| Advertisement | 8,151.00 | |
| Telephone Rental and Call charges | 10,759.50 | |
| Meeting Expenses | 17,455.70 | |
| Conveyance and Travelling expenses | 7,106.25 | |
| Bank charges | 3,993.77 | |
| Vehicle Maintenance | 26,789.67 | |
| | | 14,05,020.57 |
| Audit Fees | | 2,000.00 |
| **AMOUNT WRITTEN OFF** | | |
| Bad debts (Irrecoverable dues) | | 1,087.07 |
| **MISCELLANEOUS EXPENSES** | | |
| General contingency expenses | 8,539.45 | |
| Insurance Premium for Fire and Accident | 784.00 | |
| Repairs to Furniture & Equipment | 13,194.35 | |
| Garden Maintenance expenses | 1,125.00 | |
| | | 23,642.80 |
| **DEPRECIATION** | | |
| On Furniture and Equipment | 31,773.56 | |
| On Motor Cars, Motor cycle, Mini-Bus, Auto cycle (Met out of Fixed Assets Fund as per Schedule 'B') | 20,118.96 | |
| | | 51,892.52 |
| Carried over | | 15,27,235.81 |

| INCOME | Rs. | Rs. |
|---|---|---|
| Brought over | | 9,89,747.43 |
| **DONATIONS (Contd..)** | 7,36,665.75 | |
| iii) Life Membership Contribution Individuals | 2,77,673.25 | |
| | | 10,14,339.00 |
| **GRANTS** | | |
| i) Grant Govt. of Maharashtra for 1987-88 for Establishment, Building Maintenance expenses (including Rs.31,341/— for Nature Study Teaching Scheme) | 2,15,000.00 | |
| ii) Grant from Indian National Science Academy for the Publication of Journal printing expenses | 5,000.00 | |
| iii) Other Grants as per Schedule 'C' | 67,19,256.97 | |
| | | 69,39,256.97 |
| **INCOME FROM SUBSCRIPTIONS AND ENTRANCE FEES** | | |
| Members Subscription (Individual) | 2,30,286.06 | |
| Student Membership subscription | 6,915.00 | |
| Corporate Membership subscription | 26,877.00 | |
| Subscription to Journal from individual members | 27,528.00 | |
| Subscription to Journal from non-members | 73,119.25 | |
| Entrance fees | 34,495.00 | |
| | | 3,99,220.31 |
| Carried over | | 93,42,563.71 |

| EXPENDITURE | | Rs. | Rs. |
|---|---|---|---|
| Brought over | | | 15,27,235.81 |
| **AMOUNT TRANSFERRED TO RESERVE OR SPECIFIC FUNDS** | | | |
| i) Life Membership Fund contribution during the year | | 2,77,673.25 | |
| ii) Other Funds Specific donations transferred to respective fund accounts | | 6,54,350.00 | |
| iii) Interest on earmarked Investment/Donations | | 2,63,852.45 | |
| iv) Sale proceeds of publications to Govt. Publication Fund | | | |
| a) Book of Indian Reptiles | 20,104.42 | | |
| b) A Century of Natural History | 46,101.95 | | |
| c) Encyclopedia of Indian Natural History | 2,82,000.00 | | |
| | | 3,48,206.37 | |
| v) Grant Govt. of Maharashtra for Nature Study Teaching Scheme for 1987-88 transferred to separate receipt and payment account of N.E. Scheme | | 31,341.00 | |
| | | | 15,75,423.07 |
| **APPROPRIATION TO SPECIFIC FUNDS** | | | |
| i) BNHS Publication Fund 50% Royalty amount on Dr Salim Ali's royalty income | | 82,471.40 | |
| ii) Dr Salim Ali Memorial Fund (transferred from the Income during the year) | | 4,00,000.00 | |
| *Contd...* | | 4,82,471.40 | |
| Carried over | | | 31,02,658.88 |

| INCOME | Rs. | Rs. |
|---|---|---|
| Brought over | | 93,42,563.71 |
| **INCOME FROM PUBLICATIONS** | | |
| Journal Sales | 8,056.00 | |
| Book of Indian Birds | 48,279.66 | |
| Book of Indian Animals | 21,951.25 | |
| Some Beautiful Indian Trees | 4,755.00 | |
| Some Beautiful Indian Climbers and Shrubs | 10,896.70 | |
| Identification of Poisonous Snake Charts | 175.00 | |
| Synopsis of Birds of India and Pakistan | 4,319.00 | |
| Grasse s of Western India | 1,101.50 | |
| Hornbill Stickers | 380.00 | |
| Nature Calendars and Calendar Card sets | 1,50,300.65 | |
| Other Publications | 9,035.29 | |
| Greeting Cards | 2,25,546.05 | |
| Book of Indian Reptiles | 46,101.95 | |
| Encyclopedia of Indian Natural History | 2,82,000.00 | |
| | 8,33,002.47 | |
| Less: Packing &Forwarding Charges | 119.96 | |
| | | 8,32,882.51 |
| Carried over | | 1,01,75,446.22 |

| EXPENDITURE | Rs. | Rs. | INCOME | Rs. | Rs. |
|---|---|---|---|---|---|
| Brought over | | 31,02,658.88 | Brought over | | 1,01,75,446.22 |
| **APPROPRIATION TO SPECIFIC FUNDS (Contd..)** | 4,82,471.40 | | **MISCELLANEOUS INCOME** | | |
| iii) Staff Gratuity Fund (transferred from the Incomeduring the year) | 2,00,000.00 | | Miscellaneous receipts (general) | 12,450.70 | |
| iv) General Reserve Fund (transferred from the Income during the year) | 1,00,000.00 | 7,82,471.40 | Surplus on members Nature camps | 28,889.73 | |
| **EXPENSES ON OBJECTS OF THE TRUST** | | | Exchange fluctuation (Grindlays Bank, London) | 6,168.62 | |
| i) Educational met from respective funds as per Schedule 'B' | 1,86,279.32 | | Fees for the use of Society's transparencies | 3,300.00 | |
| ii) Expenses met out of grants as per Schedule 'C' | 67,19,25697 | | Royalty on Dr Salim Ali's Publications | 1,64,942.81 | |
| iii) Expenses incurred for the survey of Dang Forest met out of Donation from Shri Purushottamdas & Divaliba Charitable Trust and Dr Salim Ali Nature Conservation Fund interest | 60,000.00 | | Receipts from members activity under Nature Education Scheme | 40,475.00 | 2,56,226.86 |
| iv) For publishing the Society's Journal (including Rs.5,000/- from Indian National Science Academy) | 3,04,975.05 | | **ADMINISTRATIVE FEES** | | |
| Postage for the despatch of Journal to members & others | 95,392.80 | | For handling Greeting Cards sales | 30,756.28 | |
| Journal to members & others | 95,392.80 | | For handling publication sales under Govt. Publication Fund | 16,663.53 | |
| v) For Publishing Hornbill Newsletter | 1,31,800.90 | | For handling Project funds | 8,22,773.03 | |
| **LIBRARY ACCOUNT** | | | For handling other earmarked funds | 23,567.77 | 8,93,760.61 |
| Subscription to other Societies | 4,109.00 | | **AMOUNT DRAWN FROM SPECIFIC FUNDS AS PER SCHEDULE 'B'** | | |
| Purchase of Books | 1,292.40 | | i) From the interest on Salim Ali Nature Conservation Fund for the expenditure on Nature Education Scheme expenses budget | 20,000.00 | |
| Library Book binding and other Library expenses | 4,618.65 | 75,07,725.09 | ii) From Chacko Fund for Nature Education Scheme expenses budget | 10,000.00 | |
| | | | *Contd...* | 30,000.00 | |
| Carried over ... | | 1,13,92,855.37 | Carried over | | 1,13,25,433.69 |

| EXPENDITURE | | | INCOME | | |
|---|---|---|---|---|---|
| | Rs. | Rs. | | Rs. | Rs. |
| Brought over | | 1,13,92,855.37 | Brought over | | 1,13,25,433.69 |
| **MAINTENANCE REFERENCE COLLECTION** | 8,718.80 | | **AMOUNT DRAWN FROM SPECIFIC FUNDS** *(Contd..)* | 30,000.00 | |
| **EXPENSES ON FIELD STUDY PROGRAMME AND OTHER MEMBERS ACTIVITY** | 20,359.24 | | iii) From the interest on Pirojsha Godrej Foundation Field Work Fund | 9,262.95 | |
| | | | iv) From Plant Study Fund | 11,618.05 | |
| **STAMP EXHIBITION** | 650.00 | | v) From Dorabjee Tata Trust Field Work Fund | 3,000.00 | |
| **EXPENSES UNDER THE “STUDIES IN NATURAL HISTORY** | 29,081.00 | | vi) From Watanmal Boolchand Charitable Trust Field Work Fund for Natural History Study Budget | 5,200.00 | |
| **EXPENSES UNDER NATURE EDUCATION SCHEME** | 87,795.75 | 1,46,604.79 | Amount transferred from Fixed Assets Fund towards depreciation as per Contra | 51,892.52 | |
| Excess of Income over expenditure transferred to Balance Sheet | | 1,32,585.97 | Amount drawn from Gratuity Fund towards payment for Gratuity to staff members | 19,359.60 | |
| | | | Amount drawn from the interest on Dr Salim Ali Nature Conservation Fund for Dang Forest Survey | 30,000.00 | |
| | | | From various specific funds towards expenses on objects of the Trust as per Schedule ‘B’ | 1,86,279.32 | 3,46,612.44 |
| Total Rupees | | 1,16,72,046.13 | Total Rupees | | 1,16,72,046.13 |

BOMBAY NATURAL HISTORY SOCIETY

HON.SECRETARY HON.TREASURER
TRUSTEE

AS PER OUR REPORT OF EVEN DATE

HABIB AND COMPANY
CHARTERED ACCOUNTANT
BOMBAY

Bombay,
Dated : 15 September 1989

## BOMBAY NATURAL HISTORY SOCIETY

### NATURE EDUCATION SCHEME
### RECEIPTS AND PAYMENTS ACCOUNTS FOR THE PERIOD 1ST JANUARY 1988 TO 31ST MARCH 1989

| RECEIPTS | Rs. | Rs. | PAYMENTS | Rs. | Rs. |
|---|---|---|---|---|---|
| To Balance as on 1st January 1988 | | | By Refund of advance to Bombay Natural History Society | | 27,855.62 |
| 1) With Grindlays Bank Plc on current account | 209.06 | | " Salaries (Nature Education Organiser) | | 46,993.95 |
| 2) With Nature Education Organiser | 200.00 | 409.06 | " Printing & Staionary account | | 1,218.50 |
| | | | " General Charges Account (Nature Education Scheme expenses) | | 6,418.66 |
| | | | " Postage account | | 835.10 |
| GRANTS | | | " Balance as at 31st March 1989 | | |
| Govt. of Maharashtra for the year 1987-88 | | 31,341.00 | 1) With Grindlays Bank Plc., Bombay, on current account | 4,126.85 | |
| Contribution from Members for Nature Education Scheme Activity | | 6,000,00 | 2) With Nature Education Organiser | 200.00 | 4,326.85 |
| Sale of Nature Study Booklets | | 684.15 | | | |
| Advance from Bombay Natural History Soceity | | 49,214.47 | | | |
| Total Rupees | | 87,648.68 | Total Rupees | | 87,648.68 |

BOMBAY NATURAL HISTORY SOCIETY

HON.SECRETARY HON.TREASURER
TRUSTEE

AS PER OUR REPORT OF EVEN DATE

HABIB AND COMPANY
CHARTERED ACCOUNTANT
BOMBAY

Bombay,
Dated : 15 September 1989.

## THE SOCIETY'S PUBLICATIONS

**The Book of Indian Animals,** by S. H. Prater, 4th edition (reprint). 28 plates in colour by Paul Barruel and many other monochrome illustrations. (*Price to members Rs.* 90)

**The Ecology of the Lesser Bandicoot Rat in Calcutta,** by James Juan Spillett. Rs. 10

**The Book of Indian Birds,** by Sálim Ali. 11th (revised) edition. 74 coloured and many monochrome plates. (*Price to members Rs.* 90)

**A Pictorial Guide to the Birds of the Indian Subcontinent,** by Sálim Ali & S Dillon Ripley (*Price to members Rs.* 155)

**A Synopsis of the Birds of India and Pakistan,** by S. Dillon Ripley II. An up-to-date checklist of all the birds resident and migrant, including those of Nepal, Bhutan, Bangladesh and Sri Lanka, 2nd edition. (*Price to members Rs.* 90)

**Checklist of the Birds of Maharashtra,** by Humayun Abdulali, 2nd edition. Rs. 5

**Checklist of the Birds of Delhi, Agra and Bharatpur,** by Humayun Abdulali & J. D. Panday. Rs. 5

**The Book of Indian Reptiles,** by J. C. Daniel ((*Price to members Rs.* 90)

**Some Beautiful Indian Climbers and Shrubs,** by Bor and Raizada. With many coloured and monochrome plates. 2nd edition. (*Price to members Rs.* 120)

**Grasses of Western India,** by Toby & Patricia Hodd. With 64 monochrome plates. (*Price to members Rs.* 37.50)

**Encyclopedia of Indian Natural History,** Edited by R. E. Hawkins (*Price to members Rs.* 225)

**A Century of Natural History,** Edited by J. C. Daniel (*Price to members Rs.* 145)

## TERMS OF MEMBERSHIP

**Entrance Fees :**

| | |
|---|---|
| Ordinary and Life Members | Rs. 50 |
| Student Members | Rs. 10 |

**Subscription :**

| | |
|---|---|
| (*a*) Ordinary individual Members | Rs. 75 |
| (*b*) Ordinary Corporate Members | Rs. 250 |
| (*c*) Ordinary Members resident outside India | Rs. 350 |
| Life Members | Rs. 2000 |
| Life members resident outside India | Rs. 5000 |
| Student Members (without Journal) | Rs. 25 |
| Annual subscription to Journal for non-members | Rs. 270 |
| Annual subscription to Journal for members | Rs. 80 |

Members residing outside India should pay their subscription by means of orders on their Bankers to pay the amount of the subscription to the Society in Bombay on the 1st January in each year. If this cannot be done, then the sum of £ 30 (£ 15 fees, £ 15 as subscription for Journal) should be paid annually to the Society's London Bankers—The Grindlays Bank Ltd., 13, St. James's Sq., London SWIY 4LF. Account No. 1101091.

The subscription of members elected in January, February and March covers the period from the date of their election to the end of March of the following year.

ISSN 0006–6982

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